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CULTIVATION OF RICKETTSIAE OF THE ROCKY MOUNTAIN SPOTTED FEVER, TYPHUS AND Q FEVER GROUPS IN THE EMBRYONIC TISSUES OF DEVELOPING CHICKS[1]

By Dr. HERALD R. COX

THE ROCKY MOUNTAIN LABORATORY, THE NATIONAL INSTITUTE OF HEALTH, HAMILTON, MONT.

I AM deeply conscious of the honor which the American Association for the Advancement of Science has conferred in selecting me as the recipient of the Theobald Smith award.

I take this opportunity to express my appreciation to my former chief, Dr. Peter K. Olitsky, of the Rockefeller Institute, for his continued and neverfailing interest in my work, to Drs. R. R. Parker, director of the Rocky Mountain Laboratory, and R. E. Dyer, chief of the Division of Infectious Diseases, The National Institute of Health, for their sympathetic understanding and cooperation in making these studies possible, and to my assistants, E. John Bell and Lyndahl E. Hughes, for their loyal and invaluable aid.

In 1938 the author reported: First, a simple tech-

[1] Contribution from the Rocky Mountain Laboratory (Hamilton, Montana) of the Division of Infectious Diseases of the National Institute of Health. Address delivered on September 22, 1941, to the Section on Medical Sciences upon receipt of the Theobald Smith Award of the American Association for the Advancement of Science.

nique by which the rickettsiae of the Rocky Mountain spotted fever and typhus groups can be cultivated abundantly in the yolk sac of the developing chick embryo; and secondly, that suspensions of yolk sacs infected with spotted fever or typhus rickettsiae are from 100 to 1,000 times more infective than other tissues of the developing chick embryo or mammalian tissues.[2] Later it was shown that yolk sac cultures were highly suitable for the production of consistently good immunizing vaccines for Rocky Mountain spotted fever, European and endemic typhus and American "Q" fever.[3, 4, 5, 6, 7] In the following pages the present method for initiating and maintaining passage strains in eggs will be described and the results of the use of the yolk sac technique for cultivating rickettsiae and preparing rickettsial vaccines brought up to date.

Method of Inoculating Eggs and Maintaining Strains

Briefly, this is as follows: Fertile eggs incubated for 6 to 7 days at 39° C. are injected in the yolk with infectious material by means of a hypodermic syringe and a 20-gauge needle, 1 to 1¼ inches long. The inoculum, consisting of 0.5 to 1.0 cc of infected, defibrinated guinea pig blood, testicle washings, spleen or brain is introduced through a needle-sized opening in the air-sac end of the egg. After sealing the hole with paraffin, the inoculated egg is incubated at 32° C. in the case of spotted fever, or at 37° C. for typhus or the other rickettsial infections discussed in this paper. Upon death of the embryo, which usually occurs in 3 to 5 days, depending upon the species of rickettsia used, transfer to other fertile eggs is made by means of 0.5 cc of a 5 to 10 per cent. suspension of yolk sac in a 50–50 mixture of sterile beef infusion broth and saline or by using a like quantity of undiluted yolk fluid. Passage strains can be maintained by either method. Yolk fluid is satisfactory for maintaining strains, but when the tissues are to be used for vaccine production, yolk sac suspension is the preferred inoculum because of its markedly greater infectiveness.

Rickettsiae of the following diseases have thus far been cultivated and studied by means of the above-described technique: Rocky Mountain spotted fever (a western Montana, *Dermacentor andersoni* strain and an Iowa, *Dermacentor variabilis* strain), endemic typhus (Wilmington strain), epidemic or European typhus (Breinl strain), boutonneuse fever (a Moroccan strain), Brazilian spotted fever (São Paulo and Minas Geraes strains), Tobia petechial fever of Colombia, *maculatum* infection (from *Amblyomma maculatum* collected in Texas and Georgia), Australian and American "Q" fever, and South African tick-bite fever.

This method has also been used by others for cultivating rickettsial agents, viruses, bacteria and spirochetes.

When establishing strains in eggs there is a period of adaptation before optimal growth occurs. In the first few passages the embryo does not die for a relatively long period, and maximum multiplication of rickettsiae is usually not achieved before 4 to 6 passages. Strains once established can apparently be maintained indefinitely. As a matter of fact, we have had to rely upon the egg method for the uninterrupted maintenance of certain rickettsial strains such as boutonneuse fever, "maculatum" infection and *variabilis* strains of spotted fever. At Hamilton these can be maintained in guinea pigs either not at all or only with the greatest difficulty.

Guinea pigs inoculated with recently established yolk sac strains of the various rickettsioses studied exhibit the following differences when compared with animals receiving guinea pig passage strains: The incubation is usually shortened to 24 to 48 hours; the fever is higher and the febrile period more prolonged; endemic typhus, European typhus, "maculatum" infection and *D. variabilis* spotted fever infections are sometimes fatal; erythema and swelling of the scrotum is frequent in animals infected with European typhus and *variabilis* spotted fever and is intensified in those ill with boutonneuse fever, endemic typhus, "maculatum" infection and the highly fatal type of spotted fever and its South American relatives; scrotal necrosis and sloughing is often more extensive in those infections in which it commonly occurs and may occasionally be seen in diseases in which otherwise it never appears; and finally, in titrations of highly virulent strains of spotted fever even the end-point infective dilution causes fatal infection and death. However, this quality of increased virulence for guinea pigs does not persist with further guinea pig passage. Instead, the usual strain characteristics are generally regained within 3 or 4 transfers.

After strains are carried through a number of yolk sac passages a rather constant killing time for the embryo is established. Guinea pigs inoculated with concentrated yolk sac suspensions of the later egg passages may still show a shortened incubation period, yet the severity of the course of infection is noticeably lessened, as a rule, and in quantitative tests animals that receive the higher dilutions often suffer only inapparent, immunizing infections. This has been found

[2] Herald R. Cox, *Pub. Health Rep.*, 53: 2241, 1938.
[3] *Ibid.*, *Pub. Health Rep.*, 54: 1070, 1939.
[4] Herald R. Cox and E. John Bell, *Pub. Health Rep.*, 55: 110, 1940.
[5] Herald R. Cox, "Cultivation of Rickettsiae in the Embryonic Tissues of Developing Chicks." Presented before the Sixth Pacific Science Congress, July 29, 1939.
[6] Herald R. Cox and E. John Bell, *Pub. Health Rep.*, 54: 2170, December 8, 1939.
[7] Herald R. Cox, *Am. Jour. Trop. Med.*, 20: 463, 1940.

true for all the rickettsial strains studied, but particularly so for those of American and Australian "Q" fever and the *Dermacentor variabilis* strain of spotted fever.

The features that make the yolk sac technique of particular value are its extreme simplicity and the ease with which cultures may be maintained with a minimal risk of contamination. During the past year we have used approximately 30 dozen eggs daily and have found contaminants in less than 1 egg in 2,500.

Preparation and Potency Testing of Vaccines

Experience has suggested that it is best to use only organisms of maximum virulence in the preparation of *killed* vaccines. Therefore, our present practice is to use for this purpose only strains that have been carried through a limited number of egg passages. Rocky Mountain spotted fever and typhus strains employed for vaccine manufacture are alternated between a series of 40 to 50 yolk sac passages and several transfers through guinea pigs. Nevertheless, we have produced good vaccines against spotted fever and European typhus with materials from eggs of the 246th and 90th passages, respectively.

Vaccines have been prepared by a variety of methods, too numerous to mention. Several have given good results consistently. We will describe only the one that has been employed in making the bulk of the Rocky Mountain spotted fever and epidemic typhus vaccines used for field trials. While the pooled embryonic tissues were used (yolk sac, chorio-allantois and embryo) for these vaccines, we have ample evidence that much richer vaccines in proportion to residual protein may be prepared from only the yolk sac and chorio-allantois or from yolk sac alone. *Again I wish to emphasize that good vaccines can not be obtained consistently without using the yolk sac.*

Upon death of the embryos (in spotted fever this occurs 2 to 3 days, in typhus 4 to 5 days, after inoculation) the pooled embryonic tissues are harvested from all eggs of the same transfer. These are weighed and homogenized to a 12½ per cent. suspension in saline containing 0.5 per cent. phenol and 0.3 per cent. formalin.[8] This suspension is centrifuged at 5,000 r.p.m. for 50 to 60 minutes and the supernatant fluid, which contains the great bulk of lipoids and some soluble proteins, is poured off. The sediment is resuspended with aid of the homogenizer in a volume of saline equal to the original weight of the pooled tissues. Phenol and formalin are added to give a final concentration of 2.0 per cent. and 0.3 per cent., respectively. The resuspended material is placed at room temperature for 6 to 7 days and shaken vigorously daily. During this interval the great bulk of protein is precipitated by the phenol. The suspension is then diluted with 5 volumes of sterile saline and stored at 36° F. for 7 or more days. It is finally centrifuged at 2,500 to 3,000 r.p.m. for 20 minutes, and the resulting supernatant fluid constitutes the vaccine.

The method of preparation described does not give as great a yield as the one previously reported, but does produce a more potent vaccine with less residual extraneous protein. It is highly practical from the standpoint of cost, ease of manipulation and quantity production. Approximately one liter of vaccine can be prepared from 20 eggs. A bacteriologist and two assistants, provided with proper facilities, can readily prepare from 40 to 50 liters of vaccine per week. At Hamilton we have found it feasible to prepare these vaccines in lots of 25 to 35 liters each.

Potency Tests

Seven guinea pigs are used for testing the potency of each lot of spotted fever vaccine. Each animal receives two ½ cc injections of vaccine subcutaneously 5 to 7 days apart. Fourteen days later each is tested for immunity by injecting intraperitoneally 1 cc of citrated blood taken from infected guinea pigs on the third or fourth day of fever. A suitable number of control guinea pigs receive the same inoculum. Highly virulent strains that kill 80 per cent. or more of the control animals are always used, and repeated tests have shown that 1 cc of such infected blood contains from 100 to 1,000 infectious doses for guinea pigs. Temperatures are taken daily for 10 days, and animals that show temperatures of 39.8° C. or higher for 2 or more consecutive days are considered as having spotted fever unless it is quite obvious that some intercurrent infection is present. Five of the 7 test guinea pigs must show complete protection before the lot of vaccine is considered usable.

Typhus vaccine is tested in much the same manner. Twelve guinea pigs are used for the potency test, and each receives two 1 cc injections of vaccine. The test dose for immunity consists of 1 cc of a lightly centrifuged (1,500 r.p.m. for 10 minutes in an International Size 2, horizontal head centrifuge) 5 per cent. suspension of infected brain tissue taken from guinea pigs on the fourth or fifth day of fever. Repeated tests have shown that this inoculum contains 100 to 1,000 infectious doses. Temperatures are taken for 18 days, and 9 of the 12 vaccinated guinea pigs must show complete protection before the vaccine lot is issued.

Quantitative tests carried out recently with vaccines prepared as described above revealed that guinea pigs can be completely protected against the standard test

[8] We have found the Waring-Blendor unit (manufactured by the Waring Corporation, New York City) to be an invaluable aid for homogenizing large amounts of tissue in minimum time. A 51° angle centrifuge was used in all experiments.

dose of spotted fever blood virus by giving them as little as 1/16 cc of vaccine on two occasions. In other experiments it was found that the standard dose of vaccine used in the spotted fever and typhus tests protected guinea pigs in each instance against 100,000 to 1,000,000 infectious units of yolk sac virus. These results certainly indicate a high degree of protection. However, as previously stated, still more potent vaccines can readily be prepared by simply increasing the relative concentration of yolk sac tissue in the final product.

Antigenicity of Chick Embryonic Tissues

I wish to emphasize that we early recognized the serious problems involving sensitization that might arise through the use of such a vaccine. Animal experiments along these lines can be summarized by stating that guinea pigs injected with amounts of vaccine varying from 0.1 to 1.0 cc proved to be entirely unaffected by a shocking dose of 1 cc of the same material given intracardially 20 to 40 days later. These results suggest that any serious sensitization problem is unlikely.

Data collected in vaccinating the personnel of the Rocky Mountain Laboratory and the results of rather extensive field trials carried out this past year appear to support this premise. The laboratory group receiving chick vaccine consisted of 170 persons, including families of the workers. The number of vaccinations and amounts given ranged from a single injection of ½ cc to 14 doses of 1 cc each. In these tests monovalent spotted fever and typhus vaccines, as well as a bivalent vaccine (spotted fever and epidemic typhus) and a trivalent vaccine (spotted fever, epidemic typhus and American "Q" fever) were used. None of the vaccinated individuals reported any reaction other than a slight local tenderness at the site of inoculation, which always disappeared within a day or so.

In addition, more than 226 liters of typhus vaccine, enough for approximately 75,000 people, and more than 200 liters of spotted fever vaccine, enough for approximately 50,000 people, were used in field trials this past year.

The typhus vaccine was sent to Hungary, Rumania, Spain and China; the greatest amounts to the last two countries. Unfortunately, because of the upset conditions due to the war, the results of these trials have either been inconclusive or have failed to reach us. At the present time an attempt is being made to obtain a thorough test of the typhus vaccine in Bolivia. Drs. R. E. Dyer and N. H. Topping, of the National Institute of Health, are now in Bolivia for this purpose.

Physicians to whom the spotted fever vaccine was sent were requested to make careful observations of all people vaccinated and to immediately notify us of any consequential reaction or the occurrence of a spotted fever infection. No serious reaction has been reported. In fact, the evidence suggests that this vaccine is more readily tolerated than the tick type, and that it can be used for patients who have had to discontinue taking the latter. One report to the contrary was received. Noteworthy is the fact that there were no reactions in a number of persons known to be allergic to egg protein.

One case of spotted fever was reported in a vaccinated individual. The attending physician informed us that the patient, a man 53 years old, showed a typical rash. However, he was only mildly ill for less than 2 weeks; was not hospitalized, and continued to work some each day.

It is too early to attempt to draw any conclusions concerning the immunizing value of these vaccines in man, but the results to date are encouraging.

Other Rickettsial Vaccines

We have used essentially the same method to prepare vaccines against endemic typhus, American "Q" fever, boutonneuse fever and Tobia fever. This last-named disease apparently is a highly virulent form of spotted fever that occurs in limited areas in Colombia, South America. Spotted fever vaccine prepared from highly virulent western Montana strains confers complete protection against Tobia fever, and Tobia fever vaccine similarly confers complete protection against western Montana strains. We recently sent Tobia fever vaccine to Dr. Luis Patiño-Camargo, director of the Federico Lleras Institute, Bogotá, Colombia, who reported that it afforded complete protection to guinea pigs against his strains of Tobia fever. We are now supplying Dr. Patiño with sufficient quantities of vaccine to take care of the needs in the several endemic foci.

Preparation of Rickettsial Suspensions for Agglutination and Diagnostic Skin Tests

The abundant growth of the various strains of rickettsiae in the yolk sac has made it possible to prepare, by fractional centrifugation methods, practically pure suspensions of rickettsiae suitable for agglutination tests. Formalinized suspensions of American and Australian "Q" fever and European typhus rickettsiae have been prepared and are quite stable in storage and quite agglutinable by specific antisera. For over a year we have routinely run agglutination tests for American "Q" fever on all sera sent in for Weil-Felix, *B. tularense* or *B. abortus* tests.

More recently we have prepared partially purified suspensions of Rocky Mountain spotted fever rickettsiae, and studies are now in progress to determine if

these, as well as similar suspensions of European and endemic typhus and American "Q" fever rickettsiae, can be used for diagnostic skin tests.

The method of thus preparing practically pure suspensions of rickettsiae by relatively simple procedures opens up many additional possibilities of study along immunological, serological and chemical lines.

Observations Relative to a *Dermacentor variabilis* Strain of Rocky Mountain Spotted Fever Modified During Yolk Sac Passage

In conclusion I would like to report observations relative to a *Dermacentor variabilis* strain of spotted fever that has been maintained in eggs for 240 serial transfers since April, 1938. This strain was originally isolated in guinea pigs by inoculating them with a suspension of tissues from *Dermacentor variabilis* ticks collected in Iowa. Several transfers with spleen tissue were successfully made in guinea pigs, but the infection was very mild and a number of animals showed only inapparent infections or failed to react. The strain in guinea pigs was finally lost, but fortunately had already been established in eggs. Tests carried out with yolk sac suspensions of the eleventh and fifteenth egg passages revealed that a marked change, characterized by much greater virulence for guinea pigs, had taken place. Thirty-six guinea pigs were inoculated intraperitoneally with 1 cc each of a 10 per cent. yolk sac suspension. All had high fevers, prolonged temperature curves, erythema and swelling of the scrotum. Of 19 that showed scrotal necrosis and sloughing, 10 died. Titration tests of this same suspension resulted in frank infections, typical of spotted fever in dilutions up to and including one to a million. No inapparent immunizing infections occurred in those animals inoculated with higher dilutions. This enhanced virulence was maintained through about 50 passages. Tests made at random between the fiftieth and one hundred and twenty-fifth egg passages revealed the yolk sac suspensions were becoming markedly less virulent and that a great number of inapparent, immunizing infections were being induced in inoculated guinea pigs. For the subsequent 100 and more passages this strain has regularly killed chick embryos on the third day after inoculation and stained yolk sac preparations have shown just as many rickettsiae as any of our highly virulent strains, yet guinea pigs inoculated intraperitoneally with as much as 1 cc of a 10 per cent. yolk sac suspension have either failed to show any febrile reaction or at most exhibit a slight temperature rise lasting not more than 1 or 2 days. Animals injected subcutaneously with similar suspensions seldom show any reaction. In fact, we have titrated yolk sac suspensions of this avirulent, *variabilis* strain on numerous occasions and found that inapparent, immunizing infections resulted in guinea pigs receiving dilutions as high as 1 to 100,000. However, *the important finding* is that these animals, even when completely afebrile, are later solidly immune to massive doses of highly virulent strains. Furthermore, identical results have been obtained in rhesus monkeys. Attempts to reestablish this strain in guinea pig passage by transfers of blood, testicular washings and spleen suspensions have thus far failed.

Long-term tests are now under way to determine if the degree of protection afforded by this avirulent strain is as solid and lasting as that produced by killed vaccines. Theoretically, we believe it should be even more so. If this proves true, we may eventually be able to immunize man with modified, living strains of spotted fever virus in much the same way as we now immunize against yellow fever. We already have evidence that European typhus, endemic typhus and American and Australian "Q" fever as well as certain other rickettsial strains may similarly be modified in virulence for mammalian hosts by prolonged maintenance in eggs.

RAFINESQUE'S INTERESTS—A CENTURY LATER: MEDICINAL PLANTS[1]

By Dr. H. B. HAAG

DEPARTMENT OF PHARMACOLOGY, MEDICAL COLLEGE OF VIRGINIA, RICHMOND

To have been selected to participate in this Centennial Memorial to Constantine Rafinesque brings to me feelings of profound humility, on the one hand, those of great satisfaction on the other; humility because the mental stature and achievements of Rafinesque so dwarf those of ordinary men as to make him almost legendary; satisfaction because of the honor so deeply felt in being allowed to become affiliated with this magnificent occasion and because, secondly, it gives me an opportunity of expressing thoughts concerning plant drugs which I have entertained for some time silently. I was indeed happy when Dr. Brown assigned me the subject dealing with some of the problems within the field of medicinal plants.

[1] Part of a symposium during the Rafinesque Centennial Memorial, Transylvania College, Wednesday, October 30, 1940, Lexington, Ky.

It might be of interest first to discuss the status of medicinal plants at about the time Rafinesque was teaching medical botany here in the medical department of Transylvania College, and to mention some of the factors which were then beginning to make their effects felt on the popularity of vegetable drugs. In the early nineteenth century our national conscience, medically, was awakened to the need of standardizing in some fashion the quality of the medicinals then in vogue. This led the New York Medical Society, through the initiative of Dr. Lyman Spalding, on March 4, 1818, to circularize the several medical bodies with the view of calling together representative district assemblages in 1819. These gatherings were to inaugurate the formation of a convention, the fruits of which were eventually to be our first national Pharmacopoeia; our first authority on drug standards. It is pleasing to note that the Medical School of Transylvania College was among those institutions which approved this movement. In April of 1819 the college administrators appointed Dr. B. W. Dudley and Dr. W. H. Richardson as their official delegates.

The Pharmacopoeia which resulted from these and other deliberations came into being in 1820, and its decennial revisions have come down to us, the present one being unquestionably the world's best Pharmacopoeia. In its preface this first national drug authority states: "It is the object of a Pharmacopoeia to select from among substances which possess medicinal power, those, the utility of which is most fully established and best understood; and to form from them preparations and compositions, in which their powers may be exerted to the greatest advantage."

Approximately 650 drugs and preparations were listed in this first book, of which about 70 per cent. were of vegetable origin. Of these, the usefulness of slightly more than 100 is still recognized by their incorporation in the present eleventh revision of the Pharmacopoeia. These include such important drugs as digitalis, hyoscyamus, belladonna, opium, cinchona and, of course, castor oil. Among those that have fallen by the wayside are "Cornu cervi (Stag's horn)," "Dracontium (Skunk cabbage)," "Dolichos (Cowhage)," "Magnolia" and "Tobacco." Whisky, now official, was absent from the first Pharmacopoeia. There have been some few dozen other additions as exemplified by chaulmoogra oil, aspidium, cascara, strophanthus and various plant derivatives such as cocaine, ephedrine, physostigmine and the caffeine group.

The isolation of morphine from opium in 1804 not only stirred interest in similar chemical studies of the active principles of other vegetable drugs, but seems to have led to a more profound study of organ chemistry generally. This eventuated in the synth sizing of alcohol by Henry Huenel in 1826 and urea by Wöhler in 1828. The beginning of synthe chemistry marked the first major deviation from t interest in vegetable drugs since the time of Paracels in the fifteenth century. But another force was to b felt. The study of physiology was simultaneou developing and gathering momentum under su masters as Magendie, Flourens, Johannes Mueller an DuBois-Reymond. This study of function natural led to study of the various chemicals which mig influence function—the beginning of pharmacolog The early workers in pharmacology soon showed th many of the vegetable drugs then in clinical use we devoid of any beneficial action. So informed, th already therapeutically exasperated physician, swing ing to a point of juxtaposition, felt that possibly litt of therapeutic merit was to be found in any dru particularly those of vegetable origin. As a result i was not unnatural for a period of therapeutic nihi ism to ensue as the nineteenth century reached it three-quarter mark. To further the unfortunat plight of vegetable drugs, physiologists and pharma cologists devoted more and more of their time to syn thetic compounds, usually organic ones and to drug of animal origin. The desertion of the study of vege table drugs soon became almost complete; at th present time researches dealing with plant medicinal are relatively rare and are becoming more so. To-da is the heyday for organic synthetic chemicals. Pres ent-day medical scientists only too frequently are apt to look askance at those who would investigate th therapeutic possibilities of the vegetable kingdom.

In spite of this loss of dignity, out of a total of approximately 570 drugs and preparations in th present Pharmacopoeia, there are still about 260 (o 45 per cent.) of vegetable origin. These figures must not be too encouraging; many of these drugs are in cluded, not so much because of any belief as to their inherent therapeutic value, but because of their use fulness as pleasant vehicles for the more popular non vegetable remedies. And further, the indications are that the next pharmacopoeia will contain still fewer drugs of vegetable origin.

In face of such observations, is it justifiable to assume that we have exhausted the medicinal value of plant drugs? The answer is a most emphatic No!

Let us immediately recognize that even at the present time some of our most valuable drugs spring from vegetable sources. Such old drugs as opium, digitalis, cinchona, belladonna and ergot still remain almost unchallenged by synthetic opponents. As studies have been made in more recent times the value

other plant drugs and preparations has been definitely established. Such studies have led to the introduction of ephedrine, picrotoxin, curare, and others. Again, renewed attention to the older vegetable drugs has led not only to new uses, such as the successful use of belladonna in the treatment of certain diseased conditions of the central nervous system, but also to the discovery of new, therapeutically valuable principles, as exemplified by the recent isolation of the alkaloid ergonovine from ergot. This alkaloid, incidentally, was discovered years after it was supposed that all the active principles of ergot had been detected. That more has not been done is undoubtedly due to the lagging interest in drugs from this natural source. In addition to the reasons previously mentioned, this neglect is further explained because of the intense research activity shown by the chemical industries seeking new drugs in the synthetic field, which can be fairly readily protected from competition by suitable patents. Protection is more difficult in the case of studies concerning vegetable drugs. The field for exploitation is far greater in the case of synthetics than it is for that of the later group. This is not stated to disparage those responsible for the destinies of our chemical and pharmaceutical houses; these concerns have made many excellent contributions. They must look after their own interests, however, and they, as is natural, also tend to follow the custom of the day.

We have but scratched the surface in our study of medicinal plants. We have fairly well classified botanically the plants which inhabit our world; relatively their chemistry and particularly their pharmacology have been ignored. If only for purely scientific reasons this should not be so.

Now during this period of national emergency, it would be most important to know more about our national resources from the point of view of plant medicinals. Forgetting the possibilities offered by unstudied plants, it would be comforting if we had in cultivation in our country the vegetable drugs on which we lean so heavily. Of the five drugs mentioned above (opium, digitalis, cinchona, belladonna and ergot) we raise appreciable quantities of digitalis alone. Had we but found it possible to follow seriously Rafinesque's example in sponsoring a drug farm at Transylvania College, the picture would be different. It should be stated that this deficiency is due largely to economic factors. To those who are interested in following the rise and decline in medicinal plant culture in this country, I would recommend the excellent article by A. F. Sievers published in the *Journal of the American Pharmaceutical Association* for September, 1940.

It is interesting and instructive to follow the developments, often dramatic, which so frequently characterize the course of thorough observations on vegetable drugs. The leaf of the tree Erythroxylon Coca will serve as one good example. The early explorers of the Andes noted that the natives chewed an alkaline cud made of these leaves and, presumably as a result, they were enabled to work prodigiously without fatigue and to go unfed for days without hunger. The Shamans, the priest-doctors of old Peru, were observed to follow a similar custom but for a different purpose. They treated with their spittle the wounds of the patients on whom they had operated, and by so doing gave to their patients surcease from pain. This crude procedure represents the first practice of local anesthesia. Centuries pass. In 1855 and again in 1860 chemical studies in Germany revealed the presence of an alkaloid in extracts of the leaves. It was variously called erythroxyline and cocaine. That the alkaloid produced anesthesia when applied to the tongue led to no suggestion as to its use in man. This awaited the advices of the pharmacologist Anrep, who in 1879 subjected the active compound to a careful study of its action, and as a result he recommended its use to produce local anesthesia in humans. But more was needed to convince the contemporary medical opinion. As evidence of the still degraded station of cocaine in the therapeutic armamentarium of the day, it is to be noted that in 1880 a distinguished medical commission in Great Britain designated it as of little therapeutic importance: at best only a poor substitute for caffeine as a stimulant. Four years later two young scientists in Vienna began anew studies on the action of cocaine. One was to distinguish himself later in a different field—he was Sigmund Freud. The other was to become the father of modern local anesthesia, Carl Koller. Because of pressure from other duties Freud soon left Koller to carry through the studies that they began jointly. After noting that a water solution of cocaine produced deep anesthesia, in the eye of the animal into which it was dropped, Koller tried it on himself and on his friends. Then, being an ophthalmologist, he tried it as an anesthetic in operations on the human eye. Other investigators soon showed that when brought into contact with any sensory nerve it could temporarily block the passage of impulses. It was soon used in dentistry to block those nerves carrying painful impulses from the teeth. Surgeons, among them notably Dr. William S. Halsted in this country, proposed it not only for such use but for other types of so-called "conduction anesthesia." Soon, however, it was found that cocaine has two great disadvantages. It belonged to that group known as "habit-forming" drugs; and, because of self-experimentation for the

sake of science, at least one of the early investigators became a cocaine addict. It is gratifying to know that he subsequently cured himself. The second early recognized disadvantage was that this substance could at times have an alarmingly poisonous effect when used on human beings. A suitable substitute was needed. The time now was at the turn of the present century. The chemical formula for cocaine was by now so well known that pharmacologists could study various degradation products with the view of determining what part of the cocaine molecule was responsible for its benumbing action. Once this was known the chemist synthesized a series of compounds based around this active nucleus. These substances were then studied and compared with cocaine in the medical laboratory as to action, toxicity and, if possible, tendency to habit formation. One result of these observations was the introduction in 1905 of novocaine, or procaine as it is listed in the present Pharmacopoeia. This is a compound low in toxicity, satisfactorily active as a local anesthetic and devoid of the curse of habit formation. In all but its inability to produce anesthesia except when injected in close proximity to nerves, it has most of the advantages of cocaine and none of its disadvantages. To-day many other cocaine substitutes are available. Most of them, however, depend on the presence of the active cocaine nucleus for their therapeutic efficacy. And so it goes with other drugs. From the vegetable drug we learn a fundamental action, a definite clue, and then set about to improve that which gives to the natural drug its beneficial effect.

The story of opium is equally fascinating; unfortunately, the solution of the problems which now restrict its usefulness has not been solved with the same degree of satisfaction as is the case of the leaves of the "coca" tree.

The use of opium is recorded in our earliest medical archives. Mention is made of it in the Egyptian papyrus discovered in 1872 by Georg Ebers, which reveals the more popular medicinals as of the year 1552 B.C.

Collected as the juice from the poppy capsule it was used more or less in this rather crude form until the English physician Sydenham in the seventeenth century refined it into a tincture which he then called "laudanum." Epochal in its significance was the further refinement of opium therapy when Sertürner, the German apothecary, isolated morphine from opium in 1804. By animal experimentation and trial on several of his friends and himself he determined this compound to be the major active constituent of opium.

Although it had long been known that opium is a most notorious habit-forming drug, relatively little attention was paid to this problem until the turn of the present century. Then legal measures were instituted with the hope of controlling, in part at least, this marked disadvantage. But more than legal means was needed, and attempts were then made, primarily by pharmaceutical manufacturers, to find opium substitutes having the desired opium effect but free from addiction tendencies.

While some progress was made much remained to be desired. And so in 1929 a program of research was begun under the auspices of the Committee on Drug Addiction of the National Research Council. Under this cooperative scheme, the synthetic chemist, the pharmacologist and the physician all work together towards a single goal—the discovery of an ideal narcotic which could replace morphine, heroin and other similar drugs without fear of addiction. Scores of synthetic compounds bearing chemical resemblance to the natural alkaloids of opium have been synthesized and tested on animals. Some of the more promising ones have been extensively studied by the clinical component of the research triad here in Lexington under the supervision of Dr. C. K. Himmelsbach in the U. S. Health Service Hospital. While the results have been encouraging the ideal substitute has not yet been found, and so the search goes on. Here again is an example of a natural plant gift which is unrivaled in its therapeutic ability and which, due to the studies to which it serves as a cue, may eventually be the instrument whereby human suffering may be relieved to an extent never before realized and with complete safety.

Now in conclusion, from this brief summary of the chemical and pharmacological status of our knowledge of plants, three facts present themselves boldly: (1) Botanical knowledge abounds while chemical and pharmacological information concerning plants is relatively scarce. (2) Drugs belonging to the vegetable kingdom are to be found among our most important medicaments, and so we have reason to have faith in plants as a source of drugs. (3) The potentialities of the vegetable kingdom as a source of useful drugs have by no means been adequately studied.

The logical deduction is obvious. The time seems propitious for an extensive study of plant medicinals, for earnest consideration of the establishment of an institute to systematically study the chemistry and physiological action of members of the vegetable family. The rewards may be astounding, and at any event they would justify themselves solely on the grounds of scientific inquiry. We might not find another sulfanilamide, but we might find another digitalis, another belladonna, another opium. I believe that Rafinesque would have approved of this idea.

OBITUARY

AUGUST H. WITTENBORG

AUGUST H. WITTENBORG, professor of anatomy, head of the department of anatomy, chief of the division of anatomy and formerly dean of the Memphis Colleges of the University of Tennessee, died on August 21, 1941, at Ann Arbor, Michigan. His final illness was the culmination of a progressive heart disease which had compelled his leave of absence from university duties during the academic year immediately preceding his death.

Having received his preliminary education in Germany, he entered the College of Physicians and Surgeons in Memphis in 1906 and graduated therefrom in 1910 with highest honors in medicine. In his senior year he was student instructor in medical biology. During the year immediately following graduation he studied in Berlin, Vienna and other European medical centers.

Returning to Memphis in 1911, he entered private practice and became associated with the College of Physicians and Surgeons as instructor in physiology.

In 1912, when the College of Physicians and Surgeons was merged with the University of Tennessee Medical School, Dr. Wittenborg joined the staff on a full-time basis as professor and head of the department of anatomy. He retained this appointment until his death. With the organization of the faculty into divisions, in 1925, he became chief of the division of anatomy and served in this capacity also until his death.

From 1917 to 1919, Professor Wittenborg served as dean of the College of Medicine. To his devotion and courage during this critical time in the history of the college must go a major share of credit for its survival. Again, in 1921, during another crisis in the affairs of the College of Medicine, he was acting dean of this college for three months.

No statistical recital can describe the unique distinction which Professor Wittenborg enjoyed among his colleagues and students. It is difficult to express the affection and esteem in which he was held. He touched profoundly the lives of those with whom he came in contact. Students brought their personal problems to him, and returning graduates rarely failed to visit him.

His complete intellectual and personal honesty, his profound scholarship, his intuitive powers of human analysis, his incisive but kindly humor, his lively and stimulating imagination, his warm and vivid personality, the sincerity and friendliness of his interest, were qualities which made for his greatness as a teacher. His loyal devotion to the university and his high order of courage were potent factors in developing and sustaining proud standards of discipline among students and faculty. He was incapable of a mean or selfish act.

Professor Wittenborg published but little in his lifetime and was not therefore well known outside of his immediate group of colleagues. He was elected to membership in the American Association of Anatomists in 1924. He did not belong to that school which believes that medical students can learn anatomy when merely left to themselves with cadaver and text. His was a very dynamic and energetic form of teaching, one which drove home the important facts of anatomy through the frequent use of homely similes, embryological references and correlations between morphology and physiology. He believed that it was inexcusable for the anatomy teacher not to give the student the benefit of his anatomical experience, and thus to help him to acquire more easily a working knowledge of this important and difficult subject. Although he did not believe in the formal lecture in teaching anatomy, his group discussions, in which he searchingly quizzed the students, conveyed much more factual material to his listeners than do most lectures. He devoted his life to the teaching of anatomy, and probably he has had few equals as a teacher of this subject.

O. W. HYMAN
R. L. CROWE
T. P. NASH, JR.
K. B. CORBIN

UNIVERSITY OF TENNESSEE

DEATHS AND MEMORIALS

DR. WILLIAM ALBERT NOYES, professor of chemistry and director emeritus of the Chemical Laboratory of the University of Illinois, died on October 24 in his eighty-fourth year.

Nature announces the death of H. S. Ball, principal of the School of Metalliferous Mining, Cornwall, on September 26, aged fifty-three years, and of R. T. Baker, formerly curator of the Technological Museum, Sydney, an authority on Australian eucalypts and pines, on July 14, aged eighty-six years.

THE meeting of the New York Academy of Medicine on October 2 was devoted to the memory of the late Sir Frederick G. Banting. Dr. Charles H. Best, who succeeded Dr. Banting as director of the department of physiology and the department of medical research of the University of Toronto, made a memorial address and a scientific address on "Prevention of Diabetes from the Experimental Viewpoint," and Dr. Elliott P. Joslin, Boston, spoke on "The Use of Insulin in Its Various Forms in the Treatment of Diabetes."

SCIENTIFIC EVENTS

DAMAGE TO THE UNIVERSITY OF LONDON AND ITS HOSPITALS

IN his annual report, the principal of the University of London, according to the London correspondent of the *Journal* of the American Medical Association, H. L. Earson, states that the intensive air raids on London fully justified the policy of dispersal adopted by the schools of the university in the summer of 1939. The damage to university buildings has been so severe and widespread that if the schools had been in London the work would have virtually come to an end for a time. The two most important schools are University College and King's College, which are each attached to a great hospital. University College has been repeatedly attacked by high explosive and incendiary bombs, and a large part of its buildings have been destroyed. About a hundred thousand of its books in the library have been damaged beyond repair by fire and water. King's College has been damaged to a less extent, but two of its hostels and its library have been severely damaged. About one third of Bedford College (for women) has been destroyed by fire. Birkbeck College has been damaged twice, many laboratories, the operating room, books and equipment being destroyed. Damage to a less degree has been done to King's College of Household and Social Science, the Imperial College of Science and Technology and the School of Oriental Studies. The London School of Hygiene has been severely damaged by high explosives.

The hospitals of the medical schools of the university have been severely damaged almost without exception, but, owing to the decentralization of staff, students and patients under the emergency medical service, medical education has been maintained at a high level. The Medical School of St. Bartholomew's Hospital has been almost completely destroyed, and the London School of Medicine for Women has been damaged considerably. The buildings of other medical schools have sustained little damage. Notwithstanding decentralization and delays and difficulties due to disturbance of communications, the work of the university has been maintained at a high level. The number of internal students in 1939–1940 was 25 per cent. less than in 1938–1939 and this year will probably be 40 per cent. below the prewar figure. In spite of exile in strange places and air raids, the performance of students at examinations has little changed, the percentage of passes and honors being much the same as in peacetime.

THE MOUNT DESERT ISLAND BIOLOGICAL LABORATORY

THE Mount Desert Island Biological Laboratory officially closed its forty-fourth season on September 15. At the annual meeting of the laboratory corporation the following officers were elected: Ulric Dahlgren, Princeton University, *president;* Dwight E. Minnich, University of Minnesota, *vice-president;* John Whitcomb, Bar Harbor, *treasurer;* J. Wendell Burger, Trinity College, *secretary;* Roy P. Forster, Dartmouth College, director of the laboratories. William H. Cole, Rutgers University, and Homer W. Smith, New York University, were elected to serve with the president, director and treasurer on the executive committee.

At the annual meeting of the corporation the following trustees were elected to serve until 1944: U. Dahlgren, Princeton University; J. W. Burger, Trinity College; H. Bumpus, Waban, Mass.; G. Dorr and J. Whitcomb, Bar Harbor. Twelve new members were admitted to the corporation.

The laboratory plant was enlarged during the year by the construction of a new fresh-water laboratory which houses two separate research units. A plan was provided whereby the laboratory will lease some of its shore property at a nominal annual fee to active research workers for use in constructing homes. One home has been completed under this plan and another will be finished by the opening of next season.

THE PAN AMERICAN CONGRESS OF MINING ENGINEERING AND GEOLOGY

THE first Pan American Congress of Mining Engineering and Geology will be held at Santiago, Chile, during the first fortnight of January, 1942, under the auspices of the Chilean Institute of Mining Engineers, and officially sponsored by the Government of Chile.

The purposes of the congress, as stated in Article 2 of its regulations, are:

To demonstrate the progress achieved in mining and geology on the American Continent.

To analyze and consider solutions of the more important problems in this part of the world in the fields of mining and geology.

To promote a closer friendship and a permanent interchange of opinions and ideas among mining engineers and geologists of the Americas.

Attendance at the congress is open to interested parties who may register as members before December 1, in the following categories:

Official delegates designated by the various governments and duly accredited representatives of institutions.

Graduate mining engineers and geologists who may apply for membership.

Professional and non-professional persons who may be especially invited.

Persons who may wish to attend the congress and whose applications for membership may be accepted by the Membership Committee.

In addition to the above, the congress may designate honorary members.

The agenda consists of an ample coverage of various topics under eight heads as follows: Mining, Geology, Fuels, Ore Dressing and Ore Concentration, Metallurgy, Nitrate, Mining Policy, Legislation and Economy and Mining Education.

The proceedings of the congress will be conducted in Spanish, English and Portuguese, and interpreters will be made available to the members. Various tours will be arranged, which will take the members through the most interesting mining regions of Chile. The Embassy of Chile in Washington, D. C., will furnish additional information upon request.

THE ATTACK ON THE CITY COLLEGE SYSTEM OF NEW YORK CITY

DR. WALTER RAUTENSTRAUCH, chairman of the New York Branch of the American Association of Scientific Workers, has sent to SCIENCE a copy of resolutions passed by the branch on the situation in the colleges of the City of New York, the first and last of which read:

The New York Branch of the American Association of Scientific Workers has observed with deep misgivings the situation arising out of the proceedings of the Board of Higher Education, following the investigations by the Rapp-Coudert Committee of so-called subversive activities in the New York City Colleges. The evidence available points to the dismaying conclusion that the recommendations of the board, based on the committee's alleged findings, negate the fundamental civil and legal rights of the accused, and by tending to suppress freedom of thought and expression of both students and teachers, undermine the morale and seriously impair the educational effectiveness of the City Colleges.

In the light of these circumstances the members of the New York Branch of the American Association of Scientific Workers, as citizens concerned with the preservation of our democratic institutions, vigorously protest against the actions of the Board of Higher Education affecting the accused teachers and administrative workers of the City Colleges. As scientists, moreover, cherishing those conditions of free inquiry and adherence to objective fact so indispensable to the life of science, we are profoundly alarmed by the evidence of bias and unfairness, indeed of inquisitorial methods, in the hearings of the Rapp-Coudert Committee, which furnished the so-called evidence upon which the board acted. We consider it imperative that the Board of Higher Education reconsider its actions in this matter, and reinstate with full back pay all accused individuals pending fair and open hearings on the validity of the charges against them.

GREETINGS OF SOVIET MATHEMATICIANS TO AMERICAN MATHEMATICIANS

THERE was printed in the issue of SCIENCE for October 10 a letter of greetings sent to mathematicians of Soviet Russia from ninety-three American mathematicians. An answer from Moscow dated October 7 has been received. It reads:

Your splendid message, dear colleagues, found wide response in the hearts of the scientists of our country. We read it with feelings of all the more appreciation and satisfaction in that it again emphasized the community of thoughts and the friendly ties between the mathematicians of the USA and the USSR. Many years we jointly worked with you on the development of our science, many of our American colleagues were our welcomed guests, while with a still greater number of American scientists we conduct friendly scientific correspondence. This mutual cooperation was very fruitful and led to a number of important scientific discoveries.

In recent years our country became the center of gravity for eminent European mathematicians who were forced to flee the lands downtrodden by the hell of Nazi barbarians.

Our country, too, is subjected to the invasion of these gloomy medieval forces. The Hitlerites seek to smash the USSR in order to afterwards make their forces available for also destroying your great country. The fight now being waged by our people is the fight for the progress of all mankind, for everything advanced, the fight for the flourishing of civilization and of science.

Our science, too, has been placed at the service of our country for the destruction of Nazism. Soviet mathematicians, like all Soviet scientists, participate in this fight in common with the whole people. This struggle of Soviet scientists is the common cause of the scientists of all democracies, against the fiend who shoots children, burns libraries, smashes universities and destroys science.

On this momentous day your message, dear friends, has been received by us as the proof of the unity of Soviet and American scientists and their determination to fight the twentieth century vandals till the end.

Let the friendship of the Soviet and the American scientists be the surety of the friendship of our great nations, the surety of the victory of democracy over the dark forces of Hitlerism.

Among the sixty-four are: A. Sobelev, director of the Steklov Mathematical Institute of the Academy of Sciences, USSR; P. Alexandrov, president of the Moscow Mathematical Society, and corresponding members of the Academy of Sciences, USSR, the Ukrainian Academy, professors and readers of the Universities at Moscow, Leningrad, Kiev, Odessa, Kazan, Tomsk, and professors in various other institutes.

PRIORITY RATING GIVEN TO RESEARCH LABORATORIES

THE substance of a ruling from the Office of Production Management is given in the *Bulletin* of the Society for Testing Materials. Attention is called to

the fact that this rating recognizes the great importance of scientific research in the present National Defense program. The priority rating of A-2 was granted for equipment needed by research laboratories.

The Priorities Division has secured the assistance of the National Academy of Sciences in the operation of the new Research Laboratories Supplies Plan. The academy will advise upon applications from laboratories for assistance under the plan.

A laboratory experiencing difficulty in securing essential materials, and wishing to qualify for the A-2 rating, should apply to the Chemical Branch, Office of Production Management, Washington, D. C., on Form PD-88.

The preference rating may be extended as far as necessary to assure ultimate delivery of scarce materials to the laboratory. A laboratory, when applying for the rating, should specify the number of copies of the order which will be necessary to enable its suppliers to serve them upon their own subsuppliers. No extensions of the rating to suppliers will be made directly by the Priorities Division. This must be done by the laboratory itself.

In the event that the laboratory finds itself unable to obtain some essential material with the A-2 rating, it should file an application with the Priorities Division on Form PD-1. If the research project is deemed of sufficient importance, the Priorities Division will issue an individual preference rating certificate, assigning a higher rating to a particular delivery of specified material.

All correspondence should be with the OPM Chemical Branch, and not with the National Academy of Sciences.

It is also stated in the *Bulletin* that the fourth in the group of subcommittees which comprises the Advisory Committee on Metals and Minerals appointed by the National Academy of Sciences to cooperate with the Office of Production Management has been organized and the personnel announced; this is the subcommittee on nonmetallic minerals. Groups were formed previously on ferrous minerals and ferroalloys, metals conservation and substitution and tin smelting. Clyde E. Williams, director of the Battelle Memorial Institute, is chairman of the main advisory committee.

SCIENTIFIC NOTES AND NEWS

THE Frederic Ives Medal of the Optical Society of America was presented on October 24 to Dr. Selig Hecht, professor of biophysics in Columbia University, in recognition of "distinguished work in the field of optics" at the twenty-sixth annual meeting of the society in New York City. Dr. Kasson S. Gibson, president of the society, presented the medal, which was founded in 1928 by Dr. Herbert E. Ives, of the Bell Telephone Laboratories, in memory of his father. Previous recipients of the medal include Professor A. H. Pfund, the Johns Hopkins University; Dr. Herbert E. Ives; the late Professor George Ellery Hale, the Mount Wilson Observatory; Professor Robert W. Wood, the Johns Hopkins University; Professor Theodore Lyman, Harvard University, and the late Professor Edward L. Nichols, Cornell University.

D. ROBERT YARNALL, mechanical engineer of Philadelphia, Pa., has been selected as the fifth recipient of the Hoover Medal. The medal will be presented to Mr. Yarnall during the annual meeting of the American Society of Mechanical Engineers in New York City, which will be held from December 1 to 5, with the following citation: "D. Robert Yarnall, humanitarian, engineer and a leader in the engineering profession, who rendered outstanding service as a member of a mission that fed the children of Germany at the end of the World War and that is now aiding refugees in this country and Europe and providing food and relief for the children and mothers of France. These distinguished public services have earned for him the Hoover Medal for 1941." The medal was formally instituted on April 8, 1930, during the celebration of the fiftieth anniversary of the American Society of Mechanical Engineers, to commemorate the civic and humanitarian achievements of Herbert Hoover, to whom the first award was made. It was awarded to Dr. Ambrose Swasey in 1936, to John Frank Stevens in 1938 and to Gano Dunn in 1939.

DR. GEORGE W. CORNER, director of the department of embryology of the Carnegie Institution of Washington at Baltimore, has been elected a foreign corresponding member of the National Academy of Medicine of Argentina.

DR. CARL EPLING, professor of botany of the University of California at Los Angeles, will give the Faculty Research Lecture for the academic year 1941–42. This lecture is given annually by "an outstanding scholar or scientific man who has made significant contributions to the world's knowledge."

AT Yale University Dr. Alan M. Bateman, professor of economic geology, has been made Silliman professor of geology. Emeritus professors Horace S.

Uhler and John Zeleny have been appointed lecturers in physics.

PROFESSOR KENNETH K. LANDES, chairman of the department of geology of the University of Kansas and State Geologist of Kansas, is the new chairman of the department of geology of the University of Michigan.

DR. DONALD E. BOWMAN has resigned as instructor in biochemistry at the School of Medicine, Western Reserve University, to accept an appointment as assistant professor of biochemistry at Indiana University School of Medicine, Indianapolis.

WILFRED B. YOUNG, associate professor of animal husbandry and extension animal husbandman, has been appointed director of a school of agriculture for two years training on vocational lines organized at the College of Agriculture of the University of Connecticut.

DR. JAMES A. BABBITT, emeritus professor of clinical otolaryngology of the School of Medicine of the University of Pennsylvania, has been chosen president-elect of the American Academy of Ophthalmology and Otolaryngology to take office on January 1, 1943. Dr. Ralph I. Lloyd, of Brooklyn, N. Y., will become president on January 1.

DR. W. H. MILLS has been elected president of the British Chemical Society until the next annual general meeting.

DR. CLARENCE HISKEY and Dr. Harold Brailey, who were seriously burned in a chemical explosion at Columbia University on October 20 are reported to be recovering. Dr. Walter H. Zinn, research physicist, also of Columbia University, suffered second-degree burns of both hands on October 24 in a second laboratory explosion.

THE National Foundation for Infantile Paralysis has made a grant of $4,250 to the University of California Medical School, San Francisco, for the continuation of a study of methods of restoring lost power to paralyzed limbs. The work is being carried out by Drs. John B. de C. M. Saunders, professor of anatomy and lecturer in medical history and bibliography; LeRoy C. Abbott, professor of orthopedic surgery, and Verne T. Inman, clinical instructor in orthopedic surgery.

DR. E. RUFFIN JONES, JR., professor of biology at the Norfolk Division, College of William and Mary–Virginia Polytechnic Institute, has been appointed chairman of the faculty of that institution.

DR. JOHN N. MCDONNELL, assistant professor of pharmacy at the Philadelphia College of Pharmacy and Science and editor of *The American Professional Pharmacist,* has been appointed head of the health supplies and drug division of the Bureau of Research and Statistics of the Office of Production Management in Washington.

DR. G. R. TATUM, professor of physics at Baylor University, has been granted leave of absence for the session of 1940–41 in order to serve as a member of the staff in the Cruft Laboratories, Harvard University, for the training of Army officers in the use of airplane detection apparatus. Dr. Tatum is in charge of the laboratory experiments and the conference sections of the course. Approximately a hundred Army officers began the course on October 1.

AN expedition from the Field Museum of Natural History, which has as one of its objectives the determination of the date at which the Isthmus of Panama emerged from the sea, will leave for Central America in November. Paul O. McGrew, assistant curator of paleontology, and Albert Potter will leave from Chicago on November 2. They will sail from New Orleans on November 5 to Puerto Cortez, Honduras, whence they will fly to the capital, Tegucigalpa, and thence to the town of Gracias. From Gracias they will use mules for transportation while doing their field work.

DR. W. D. FUNKHOUSER, dean of the Graduate School and head of the department of zoology of the University of Kentucky, has been granted leave of absence for the year 1942 to make a collecting trip in Central and South America.

DR. ZING-YANG KUO, director of the Institute of Physiology and Psychology at Chungking, China, has visited England at the request of the Chinese Minister of Education and by invitation of the Universities' China Committee in London to seek to promote closer and more effectual cultural and educational cooperation between the two countries. After attending the conference of the British Association and a brief stay in London he visited Oxford, Cambridge, Manchester, Glasgow and other educational centers.

PROFESSOR GEORGE B. CRESSEY, chairman of the department of geology and geography at Syracuse University, spoke before the North Central Indiana Teachers Association in South Bend on October 24. In the morning he discussed "The Use of Maps in the Study of Current Events" and in the afternoon presented an illustrated lecture on "Far Eastern Geographic Strategy." The latter is also the subject of a Littauer Lecture at Hunter College in New York City on November 13.

SIR WILLIAM JAMESON, chief medical officer of the Ministry of Health, London, delivered the Cutter Lecture on Preventive Medicine at the Harvard Med-

ical School on October 22. His subject was "Public Health in Britain at War."

A CONFERENCE on "The Ultracentrifuge" will be held by the Section of Physics and Chemistry, the New York Academy of Sciences, on November 14 and 15 in the Roosevelt Memorial Building of the American Museum of Natural History. There will be an informal subscription dinner on Friday evening. Attendance will be limited to those invited to participate in the conference and to interested members of the academy.

THE fourth annual meeting of the Research Council on Problems of Alcohol will be held in New York City on November 25. There will be ten group conferences at 11:00 A.M. and a luncheon at 1:00 P.M. Dr. Edward A. Strecker, professor of psychiatry and chairman of the department at the University of Pennsylvania, will give the luncheon address.

THE Acoustical Society of America met at the Hotel Pennsylvania on October 24 and 25, under the presidency of Dr. E. C. Wente, research physicist of the Bell Telephone Laboratories. Noise abatement was one of the principal subjects considered. Many of the thirty-six papers presented were accompanied by demonstrations of the devices under discussion, which included recording and record-playing equipment, hearing aids and the devices employed by the Library of Congress in making and preserving an auditory record of our civilization. A joint luncheon of the Acoustical Society of America, the Optical Society of America and the Society of Rheology was presided over by Dr. Paul E. Klopsteg, chairman of the governing board of the American Institute of Physics. Dr. Vannevar Bush, president of the Carnegie Institution of Washington and director of the Office of Scientific Research and Development, addressed a joint meeting of the three societies.

THE semi-annual meeting of the American Association on the History of Medicine was held on October 24 and 25 at the Medical School of the University of Kansas, Kansas City, under the auspices of the Quivira Medical History Club of Western Missouri and Kansas.

THE fiftieth anniversary of the opening of the Ladd Observatory was celebrated by Brown University with a reception at the observatory on the afternoon of October 21 and a lecture in the evening by Professor Frederick Slocum, of the class of 1895, director of the Van Vleck Observatory at Wesleyan University, formerly professor of astronomy at Brown University. An exhibition of early astronomical instruments, including the transit used by Professor Benjamin West at the university in 1769, was on display. The gift of former Governor Herbert W. Ladd, of Rhode Island, the observatory was opened in 1891 after having been built and equipped at a cost of $25,000. Its principal instrument is a 12-inch refracting telescope. Professor Charles H. Smiley, director of the observatory, announced that the next expedition from Brown University will go to South America to photograph the total eclipse of the sun on January 25, 1944. Professor Smiley took part in eclipse expeditions to Peru and Brazil in 1937 and 1940.

UNDER the sponsorship of the U. S. Office of Education through its Engineering, Science and Management Defense Training Program, and in cooperation with the U. S. Department of Labor through its National Committee for Conservation of Manpower in Defense Industries, the Greater New York Safety Council and the Center of Safety Education at New York University, the College of Engineering at New York University is planning to set up at various centers in the metropolitan area a course in accident prevention and safety engineering.

THE fourteenth annual Graduate Fortnight of the New York Academy of Medicine was opened formally on the evening of October 13 with an address of welcome by the president, Dr. Malcolm Goodridge, to seven hundred registrants and attending fellows of the academy. The subject under consideration was "Cardiovascular Diseases Including Hypertension." Reviews of various aspects of the subjects were given at the evening sessions by twenty-six lecturers. There were a hundred and eighteen clinical conferences and demonstrations held in fourteen hospitals and clinics of Greater New York.

ANNOUNCEMENT has been made by the Finney-Howell Research Foundation that all applications for fellowships for next year must be filed in the office of the Foundation, 1211 Cathedral Street, Baltimore, Md., by January 1. Applications received after that date can not be considered for 1942 awards, which will be made the first of March, 1942. This foundation was provided for in the will of the late Dr. George Walker, of Baltimore, for the support of "research work into the cause or causes and the treatment of cancer." The will directed that the surplus income from the assets of the foundation together with the principal sum should be expended within a period of ten years to support a number of fellowships in cancer research, each with an annual stipend of two thousand dollars, "in such universities, laboratories and other institutions, wherever situated, as may be approved by the Board of Directors." Fellowships carrying an annual stipend of $2,000 are awarded for the period of one year, with the possibility of renewal up to three

years; when deemed wise by the Board of Directors, special grants of limited sums may be made to support the work carried on under a fellowship.

THE Committee on Scientific Research of the American Medical Association invites applications for grants of money to aid in research in problems bearing more or less directly on clinical medicine. Preference is given to requests for modest amounts to meet specific needs. As a rule grants are not made for the purchase of equipment or apparatus of a permanent nature. For application forms and further information, address the committee at 535 North Dearborn Street, Chicago.

DISCUSSION

AURORAL DISPLAY AND GEOMAGNETIC STORM OF SEPTEMBER 18–19, 1941

ONE of the greatest auroral displays ever observed in the central Atlantic and mid-central portions of the United States occurred on the night of September 18–19. Spectacular displays continued from twilight until just before dawn, and were observed as far south as Florida and southern California. The auroral activity accompanied one of the most violent magnetic storms of the present sunspot-cycle, nearly equaling in intensity and exceeding in duration the great storm of Easter Sunday, March 24, 1940. Serious interference with radio and wire communications over long distances was experienced, as well as noticeable effects on electric power-transmission lines.

This geomagnetic storm is generally ascribed to clouds of electrified particles projected from the sun in the region of an extraordinarily active sunspot-group which had crossed the solar meridian shortly before the onset of the disturbance. The progress of this sunspot-group across the sun had been followed by a number of observers for several days. Just at the time of crossing the solar meridian an increase in activity in the group was noted. Since such active groups frequently give rise to geomagnetic disturbances, H. W. Wells, of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, had warned numerous radio operators to be on the lookout for disturbances in radio transmission-conditions, so that occurrence of the magnetic storm was not entirely unexpected by scientists, although its great intensity and the extent of the auroral manifestations were not anticipated.

The storm began at 11 P.M., Eastern Standard Time, on September 17 and attained maxima of activity between 1 and 3 P.M., and between 7 and 10 P.M. on September 18. During both of these periods of intense activity, effects were noted on the 230-kilovolt interconnecting line tying the power-system of Washington, D. C., into the hydroelectric developments along the Susquehanna River in Pennsylvania, approximately 100 miles to the north. The second period of disturbance also was the time of maximum auroral activity. Changes in horizontal magnetic intensity at the U. S. Coast and Geodetic Survey Observatory at Cheltenham, Maryland, amounted to over 2,500 gammas, which is approximately 15 per cent. of the normal value at that station, the greatest change ever recorded there.

During the second active interval, which occurred during the hours of darkness, bundles of auroral rays were directed downward through the high atmosphere over the eastern section of the United States. These rays, because of the electrical nature of the particles causing them, took the direction of the earth's magnetic field and consequently assumed roughly parallel directions and approached the earth's surface in alignment with the magnetic dip which at Washington, D. C., is nearly 20° from the vertical. To observers viewing these rays they appeared to be parallel, and like all parallel lines, appeared to converge in the distance. For this reason many persons noted a spectacular coronal display of the aurora borealis where the rays appeared to converge slightly south of the true zenith toward a point known as the magnetic zenith.

Throughout the night the auroral activity exhibited various forms. At times extensive quiescent auroral arcs crossed the sky in a roughly east-west direction. These changed into draperies, rays and curtains, as the various auroral forms are picturesquely described. In the extreme northern part of the country and in southern Canada brilliant colors in the aurora were reported by many observers, although throughout the greater portion of the United States the auroral forms were with little color although occasional casts of red and green could be detected. Auroral displays were observed in the northern part of the United States on the nights of September 17–18 and 19–20 also, but of greatly diminished intensity.

No complete theory of geomagnetic storms and aurora has been developed. The most generally accepted theory attributes both to the injection into the earth's atmosphere of high-velocity electrified particles projected from active regions on the sun. These particles, entering the tenuous layers of the upper atmosphere, excite the molecules and atoms of the air and thus give rise to the auroral light in very much

the same manner as glows are produced in neon signs. The energies of these particles also ionize the atmospheric gases and render them electrically conducting so that large electric currents flow through the upper atmosphere. These produce the magnetic effects recorded by magnetic instruments and also induce electric currents in power and telegraphic lines. This electrification of the upper atmosphere is irregular in formation and consequently destroys the reflecting properties of the smooth but lesser conducting layers normally present which are responsible for reflection back to earth of radio waves traversing long distances. During the magnetic storm of September 18–19 electric currents flowing in the earth's atmosphere probably attained values of several million amperes.

Magnetic storms of intensity comparable with the recent one are extremely rare, occurring as a rule only once or twice during each sunspot-cycle. Since the present sunspot-cycle is now well on the decline, it is extremely unlikely that so great a magnetic storm accompanied by a spectacular auroral display will occur again for a considerable number of years.

A. G. McNISH
DEPARTMENT OF TERRESTRIAL MAGNETISM,
CARNEGIE INSTITUTION OF WASHINGTON

MOSSES IN THE VIRGINIA CAVERNS[1]

RECENTLY when on a visit to Luray Caverns in the Shenandoah Valley of Virginia I was surprised to see a pronounced green color appearing on many of the drip-stone formations that I had not noticed many years previously. It was evident that this green coloration was related in some way to the illuminating system, for it showed at its best on the rocks brilliantly lighted by the reflecting projectors. On close examination it was found to be a chlorophyl plant. A specimen submitted to the Farlow Herbarium of Harvard University was determined as an atypical sterile moss of the Order Hypnobryales.[2] More recently a collection of these mosses has been submitted to the Harvard herbarium for more specific identification.

Before the electric illuminating systems were installed in the Virginia caves no sign of moss or other green plant life had been seen in their dark interiors. The lighting systems were installed in most of the caves about 1922 or shortly thereafter. The moss is variously reported to have appeared in two months to two years time after the lights were put in service. With the introduction of larger bulbs and more efficient reflectors, the moss has spread over wider areas to the extent that the green tone is almost as much a part of the coloration of the cavern as the natural browns, buffs and white of the drip-stone formations. This greenish color is not objectionable but rather adds a pleasing variation to the natural color scheme.

Apparently the spores of mosses living on the surface of the ground above the caves are carried by the ground-water seepage into the caves. If they are fortunate enough to lodge within an intensely illuminated area the spores germinate and develop into mosses as much as two to three inches in length. Even ferns have been reported to grow in the caves.

Whether these mosses require the light and heat from the visible range of the spectrum or whether they can develop in total darkness under the influence of infra-red radiation is not known. But certain it is that they have not been able to germinate in these caves without the support of radiation from the electric lamps. The amount of light, or rather the extent of the time of illumination, may range from an hour or two to fourteen hours a day, depending upon the season of the year. In summer, the busy tourist season, the plants in the caves may be bathed with artificial light for as many hours a day as if they were living outside. In winter when the periods of illumination are short the plants may turn yellowish or brown and die.

As mosses are land plants their introduction into caves by the vadose waters is a relatively simple process. The wind is not a likely means of transportation of the spores, more particularly in the Luray Caverns where no noticeable air circulation is reported. The spores of mosses are apparently present at all moist places and are awaiting only sufficient light to germinate, and they in turn provide a means of support for animal life which exists with them. Algae on the other hand are water plants and their continuous introduction into areas above the water table is not so likely. Where surface streams become cavern streams there is apparently no reason why algae may not grow in caverns under the influence of sufficient artificial illumination.

WALTER B. LANG
U. S. GEOLOGICAL SURVEY

STONE MAN CAVE, SHASTA COUNTY, CALIFORNIA

INVESTIGATION of cave deposits in northern California was initiated in 1903 by Dr. John C. Merriam, and excavations were carried on up to and during 1905, principally in the Potter Creek and Samwel Caves. One cave, the Stone Man Cave, approximately 30 miles north of Redding, was examined by Dr. Merriam and the writer, but some doubt existed as to its antiquity, owing to the paucity of animal remains in the cave.[1]

[1] Published by permission of the Director, U. S. Geological Survey.

[2] Through the kindness of Dr. Franz Verdoorn, the specimen was subsequently forwarded to Professor W. C. Steere, of the University of Michigan. He pronounced it to be *Leptobryum pyriforme*.

[1] *Am. Anthropologist* (NS) 8: 2, April–June, 1906.

Recently, through the interest of Mr. H. Wallace Buckingham of Redding, who visited the Stone Man Cave, more information has been available regarding the age of the deposits found in it. In company with Mr. Buckingham, and by support of the Carnegie Institution of Washington through Dr. Merriam the cave was reexamined by the writer and a small collection of fossil bones was obtained.

The Stone Man Cave is topographically higher than Potter Creek Cave and lies north of the Pitt River and east of the McCloud River.

The mammalian remains found in the cave represent a number of species common to the Shasta caves but probably accumulated later than those of Potter Creek and Samwel caves. The presence of Arctotherium, the large short-faced bear, Equus sp., Odocoileus sp. and a number of rodent species suggests a time relationship with that of Potter Creek Cave and Samwel Cave. Split and gnawed parts of limb bones that were so common in the other caves are present.

A statement regarding the avian skeletal material found in Stone Man Cave, as reported upon by Miss Ida DeMay, follows:

> The bird remains also represent species included in collections from the Shasta caves. A fragment of an ulna may be assignable to *Gymnogyps amplus*, an extinct condor described from Samwel and Potter Creek Cave material by Loye Miller in 1911 (Univ. Calif. Publ., Bull. Dept. Geol., vol. 6, pp. 385–400). This species is the only condor that has been recorded from the Pleistocene of Shasta County. Bone fragments probably representing the sooty grouse (*Dendragapus fuliginosus*) and two bones of the band-tailed pigeon (*Columba fasciata*) also occur in the collection. Both of these species are found in the region to-day.

E. L. FURLONG
CALIFORNIA INSTITUTE OF TECHNOLOGY

REPRINT SIZE

A SHORT time ago our laboratory inherited a fine reprint collection from a physiologist. The problem then arose of the best method of making these 10,000 items available to our graduate students. We decided to file them, as we had another reprint collection, in two cabinets of metal containing 5 drawers each with dividers in each drawer. The drawers were 11×17 inches.

The trouble then arose of reducing as many reprints as possible to a size less than or equal to 9×7 inches. Hence this appeal to secure reprints of standard size, either 9×6 or 9×7 inches. Isn't the time ripe to ask such journals as the *Proceedings of the Society for Experimental Biology and Medicine* to reduce their size and save the paper we have to shear from their reprints before filing? From the sixteen reprints that came to my desk this morning we sheared 15 per cent. by weight before we could file them.

Furthermore, we keep several sizes of envelopes for mailing reprints. What reason is there for most journals not standardizing their reprint size now?

CLIVE M. MCCAY
CORNELL UNIVERSITY

LEONHARD STEJNEGER

(For his ninetieth birthday, October 30, 1941)

The sons of science walk in endless line
Bearing the torch; a few falter and drop,
But the rest close in: they who have glimpsed a sign
Far on ahead that reads, "You must not stop!"
Their quests are strange and wonderful—to bring
The stars to earth, to take the earth to sky;
To know the *what* of every living thing
Of all time past, and then the *how* and *why*.

And here is one whose vision has been long
And clear and true—he saw the sign ahead.
His torch was radiant, and he held it strong;
Where it found darkness there came light instead . . .
Forever seeking truth, not vain acclaims,
He kindled, on the way, a thousand other flames.

PAUL H. OEHSER

QUOTATIONS

SCIENCE AND WORLD ORDER

THE Conference on Science and World Order, which begins to-day in London under the auspices of the British Association, is an event of considerable importance. The speakers at the meeting will undoubtedly be making valuable contributions toward the problem of sane and efficient reconstruction and the establishment of a stable world order after the war. But the mere fact of such a conference being held at this particular time and in this particular place is also significant. The conference is truly international, and it is free from any trammels on the expression of opinion. One similarly free and international conference has just been held here under the auspices of the P. E. N. Club. Another, the International Youth Rally at the Albert Hall, is due to take place next month. Taken together, these conferences are solid evidence of the new position which this country is rapidly assuming as a centre—one might almost say the centre—of leadership in international affairs, both political and cultural.

The British Association Conference, however, has an added significance in that it deals with science. Science is not truly science unless fully free. The necessary freedom of science is twofold—freedom from

internal interference and freedom for international interchange. Nazi Germany has systematically interfered with both these freedoms. The result, readily noticeable for some time before the war, was a deterioration in the quality of German scientific work, especially in fields of new and fundamental research. The Nazi régime, as the Foreign Secretary said yesterday, has effected its own intellectual encirclement. As a result it is now living on its scientific capital. This has important consequences, both for the war and for the subsequent peace. It is a remarkable fact that, in spite of the Nazis' intensive scientific preparations for war, this country has already surpassed Germany in many applications of science to war. The superiority of our aircraft and of our systems of aircraft detection is a matter of public record; and there are a number of other examples which must for the present remain as military secrets. The mobilization of the resources of a democracy behind the national effort may be slow, but is sure and cumulatively effective. This is especially true of our scientific resources. But just because we stand for freedom, in science as elsewhere, our efforts have been notably supplemented by aid from the United States. In the scientific sphere, as elsewhere, this aid is steadily increasing, and our scientific achievements, thus powerfully reinforced, may well prove to be a factor of major military importance.

The conference which opens to-day [September 26] will deal primarily with post-war problems. Much lip-service is paid to the idea of planning, but it is not always realized that planning will be neither effective nor tolerable unless it is backed by science. Every planning authority, whether comprehensive like the Tennessee Valley Authority or devoted to some special function like the Rockefeller Institute's campaign against yellow fever in South America, needs its team of research workers and scientific advisers. It is a bare three years since the century-old British Association established its Division for the Social and International Relations of Science. This conference is a proof of the validity of the idea behind that decision. In Mr. Eden's words, "from henceforth science and statecraft must march together. Diplomacy, which has up till now been the servant of higher strategy, must increasingly become the servant of science." Science in its turn must increasingly become the servant not of war, or of big business, or of a particular régime, but of the general welfare of mankind.—*The London Times.*

SCIENTIFIC BOOKS

MAMMALIAN FAUNA

The Mammalian Fauna of the White River Oligocene. Trans. Amer. Phil. Soc., N.S., Vol. XXVIII. Part I: *Insectivora and Carnivora*, by W. B. SCOTT and G. L. JEPSEN, pp. 1–154, pl's I–XXII, 1936. Part II: *Rodentia*, by A. E. WOOD, pp. 155–270, pl's XXIII–XXXIII, 1937. Part III: *Lagomorpha*, by A. E. WOOD, pp. 271–362, pl's XXXIV–XXXV, 1940. Part IV: *Artiodactyla*, by W. B. SCOTT, pp. 363–746, pl's XXXVI–LXXVIII, 1940. Part V: *Perissodactyla*, by W. B. SCOTT, pp. 747–980, pl's LXXIX–C [also contents and addenda for whole volume, pp. i–xvi]. 1941.

IN 1846 Dr. Hiram A. Prout, of St. Louis, received from a friend the fragmentary jaw of a gigantic extinct mammal, found in the "Mauvais Terre, on the White River." As years passed, this first specimen was followed by dozens, hundreds and thousands. The Mauvais Terre became the Big Badlands and badlands became a technical term for similar country all over the earth. The White River gave its name to a group of strata not only forming the Big Badlands of South Dakota but also underlying an enormous area beyond them, from Montana to Nebraska. The time represented by the deposits includes most of the Oligocene. The rich faunas have become a standard of comparison for the world. No fossil deposits have been worked more intensively and more continuously during the last century. The rising flood of notes, papers, comments and special monographs has tended to obscure the broader and more significant features of these important faunas in a mass of detail, hard to find and hard to synthesize once found.

Already in 1869 the need for such a synthesis was felt and the White River faunas were the main basis for a great memoir by Joseph Leidy, a work of 472 quarto pages and 30 plates that became a monument in the history of paleontology. Eighteen families and 25 genera were then known from the White River Group. For two generations no one had the courage to face the great task of keeping the synthesis abreast of the rapid discoveries. Then in 1934 Professor Scott undertook "to fill out and complete the admirable sketch which Dr. Leidy gave to the world." The American Philosophical Society gave a grant and undertook to publish the results. An excellent artist, R. Bruce Horsfall, was employed, and Professor Scott set out on an ambulatory research program of the sort becoming more and more necessary but seldom so successfully arranged. Twelve museums, scattered from the Atlantic to the Rockies, were successively or repeatedly bases of operation. Every genus was

studied and illustrated by its best-known specimens, wherever these happened to be. Specialists in particular groups, Drs. G. L. Jepsen and A. E. Wood, collaborated. Now after more than seven years the project is completed and is before us for appraisal and for use.

Since Leidy, the number of families of mammals known from the White River has more than doubled (it is now 40) and the number of genera has more than quadrupled (now 101). This increase in breadth of knowledge is accompanied by comparable increase in depth. Leidy had fair skulls of a dozen genera but virtually no skeletal material. Now good skulls are known for almost all genera, including so many that Leidy did not know at all, and the complete skeleton is known for more than twenty. Bringing together a sufficient summary of all these discoveries would, in itself, make this monograph an outstanding success and one of the most useful of recent publications.

Even within the span of a thousand pages, rigid limitation is necessary with so large a subject. The plan of this monograph stresses the type morphology and the taxonomy of genera. Higher taxonomic categories are designated but not, as a rule, defined and only briefly discussed. Selected specimens are measured, but the descriptions are mainly on a qualitative generic level. As for species, Professor Scott recognizes that these "would be much the more important category . . . were the necessary information available," but the imperfections of present data are such that "the significant unit is rather the genus." Although there is much that is wholly new in this great volume, the point of view is that of bringing together and holding fast the most secure results of past and recent research. Species are listed and summarized on the basis of existing data and for completeness of record, but the authors repeatedly emphasize that many of these "species" are invalid and most of them are ill-defined. No serious attempt to revise them is made.

The super-specific classification is for the most part a happy expression of the most recent and best-informed opinions. This reviewer objects to a few points of nomenclature (such as Cynoidea, Oreodontoidea, Hippoidea and some others as names for superfamilies), but such matters are nominal and of secondary importance. The major taxonomic novelty is placing the hypertraguloids and oreodonts in the Tylopoda, a return to Professor Scott's opinion of 1899, which had been generally rejected, even by its proposer. As regards the hypertraguloids, new evidence is adduced which does not quite settle the problem but which at least puts it on a new unsettled basis by showing that tylopod affinities can not be dismissed. Evidence bearing on the oreodonts is less explicit. The crux of the whole matter lies before the White River, in the Eocene, as Professor Scott notes. With characteristic energy he has already begun a similar revision of the Uinta (late Eocene) faunas, and here this difficult taxonomic question may be more fully treated.

As regards the morphological sections, it suffices to say that they are up to Professor Scott's standard, in other words, they are excellent. Necessarily compendious, they are yet adequate for any ordinary purpose and do not sacrifice either style or accuracy to brevity. Few will need ever again to go back of this monograph to the scattered older literature. The few specialists who must still seek the sources will find here a powerful aid in their search, and in the comprehension of their problems.

No study of the White River fauna will ever be final, but it is probable that this remarkable monograph is definitive. It is unlikely that future discoveries will necessitate repetition of the particular task here completed, and the end of an era of White River studies is thus marked. As Professor Scott implies, however, this is at the same time the beginning of another era of study, one that will, as far as prediction is possible, be as long and laborious as all that has gone before. The general composition and character of the faunas, the major morphological characters of the included animals and the intermediate levels of their taxonomy are fairly in hand. All this basic information is gathered together in this work, a work classic in scope and style and clearly destined to become historically classic. Now the ground is cleared and the foundation laid for the paleontology of the future: detailed descriptive and functional morphology (for instance of the internal ear structures), the study of variation, of growth and of paleogenetics, the recognition of species as natural populations by group methods, the extension of taxonomic revision to higher and to lower levels, the paleoecological study of the extinct animal associations, the tracing of specific lineages and of larger populations through more exactly recorded time sequences, the integration of these still remote results with general evolutionary theory. It is the greatest tribute to this monograph and to its senior author that its value is not alone that of major research well completed but also that of a signpost and a stimulant for still more arduous work now barely begun.

GEORGE GAYLORD SIMPSON
THE AMERICAN MUSEUM OF NATURAL HISTORY

PHYSICS

Vacuum Tube Voltmeters. By JOHN F. RIDER. xi + 179 pp. New York: John F. Rider, Publisher, Inc. 1941. $1.50.

As stated in the author's foreword, "This book on the Vacuum-Tube Voltmeter is intended as a practical exposition of the numerous types of such measuring devices, with the direct intention of providing a source of information for the engineer, student and serviceman, so that if he desires to compare different types, establish their principles of operation or construct them, all the facts are available from one source."

The book provides a very valuable contribution for the aforesaid purpose. It is simple in language and direct in attack, so that the instrument to be discussed is presented with the minimum of preamble. The book is practically free from mathematical equations, and in that sense is very elementary. Nevertheless, a certain amount of previous knowledge is necessary if the reader is to get the maximum of value from the work, since the significance of many of the features rests largely upon such knowledge. While the author has done what is reasonably possible within the wide scope of instruments discussed to point out pitfalls, and to state why certain situations must be avoided in certain cases, the subject of high frequency oscillations in particular is a field in which it is frequently necessary and always desirable for the investigator to have intimate knowledge of the characteristics of his circuits before assuming what will happen when any additional measuring device is incorporated with them.

While the book is intended in part for one who has no great knowledge of circuit theory, the present reviewer feels that one of its greatest uses will be for the investigator in physics who, while well equipped in a knowledge of handling circuits, is nevertheless unfamiliar with the special technical devices employed. Such a physicist will find in the book a wealth of information which may save him the labor of redevising circuits for his special needs. He can pick out what he wants, and his theoretical knowledge will then permit him to examine the instrument in all details relevant to his own particular problem.

The contents of the book may be gauged by the chapter titles, as follows:

Chapter	I.	Fundamentals of Vacuum-Tube Voltmeters.
Chapter	II.	Diode Vacuum-Tube Voltmeters.
Chapter	III.	Triode Vacuum-Tube Voltmeters.
Chapter	IV.	Slide-Back Vacuum-Tube Voltmeters.
Chapter	V.	Rectifier-Amplifier Vacuum-Tube Voltmeters.
Chapter	VI.	Tuned Vacuum-Tube Voltmeters.
Chapter	VII.	Audio-Frequency and Logarithmic Vacuum-Tube Voltmeters.
Chapter	VIII.	Vacuum-Tube Voltmeters for D-C Voltage, Current, and Resistance Measurements.
Chapter	IX.	Design and Construction of Vacuum-Tube Voltmeters.
Chapter	X.	Calibration and Testing of V-T Voltmeters.
Chapter	XI.	Applications of V-T Voltmeters.

Chapters I–VIII inclusive each contains descriptions of several different types of instruments adapted to various needs, with a general review of the underlying principles. Chapter IX, as its name implies, contains a special discussion of the elements which demand consideration in order to produce an instrument which will record what it is intended to record. Chapter X deals with a variety of matters concerned with the necessity for and means of carrying out continual checks on the instruments, and Chapter XI contains several examples of typical fields for the use of the instruments.

W. F. G. SWANN

BARTOL RESEARCH FOUNDATION
OF THE FRANKLIN INSTITUTE,
SWARTHMORE, PA.

REPORTS

STATEMENT BY THE BOARD OF DIRECTORS OF THE AMERICAN CHEMICAL SOCIETY

BECAUSE of efforts to compel chemists and chemical engineers to join labor organizations in order to obtain or retain employment in certain plants, the board of directors of the American Chemical Society has given consideration to the broad problems of employment in the field of chemistry.

So that the position of the society may not be misunderstood, the board of directors issues the following statement for the more complete information of our membership:

The society has taken no stand against "collective bargaining" for professional men when such bargaining is not controlled by non-professional groups and where the bargaining unit is composed exclusively of professional men.

The society condemns no one of its members for joining any non-coercive labor union so long as he does so voluntarily.

The society, however, is unalterably opposed to the forcible inclusion of professional men in bargaining units dominated and controlled by non-professional employes, whether that inclusion be brought about by economic pressure upon an employer, by intimidation of the professional employe or by operation of either state or federal law.

The society will bend every effort to maintain for all its members the "right to work" and the "right to

employment and promotion" on the basis of worth and merit.

Accordingly the board of directors goes on record as opposed to affiliation of its members with any organization that conditions promotion primarily on the basis of "seniority" or that insists that they join any labor organization where they would be in a minority, with no power to protect themselves while paying "protection" thereto as an essential to the privilege of earning a livelihood and with their wage scales negotiated by those whose selfish interest would require that benefits be sought for the larger number of non-professional workers to the detriment of the relatively few professional employes.

Letters from some members, supported by facts and intelligent argument, claiming that conditions during the depression and under the emergency have secured for tradesmen and laborers, under union leadership, advances in income not enjoyed by trained professional men often directly associated with the former have been given consideration.

Already a number of our more progressive employers have made surveys of their personnel and have taken, or propose to take, corrective measures.

In order that some logical conclusion may be reached, it seems wise to consider the distinction between professional and non-professional employes engaged in chemical work in order properly to differentiate between professional and non-professional workers.

At the present time there are a large number of technicians employed in the field of chemistry.

The term "technician" may be applied to routine workers, trained in the laboratory but with no special education or mental proficiency in chemistry and allied sciences. Normally they will be individuals with secondary school education only, or perhaps ones who have failed to acquire a baccalaureate degree through lack of funds, insufficient effort or capacity or attendance at under-equipped educational institutions. These are almost always paid wages on the hourly basis and are often included in labor union agreements. No proper objection can be raised to their inclusion in a bargaining unit composed of employes doing various kinds of skilled, semi-skilled or unskilled work.

The two groups of employes which should not be subjected to forcible inclusion in a heterogeneous bargaining unit are those who have received degrees in chemistry or chemical engineering and are engaged in these fields, either as chemical internes or as professionals.

The term "chemical interne" may be applied to those who are essentially in the final qualifying stage for their life work in the field of chemistry. They have received their baccalaureate degrees with majors in chemistry or chemical engineering, have proved their proficiency not only in chemistry but also in mathematics, physics, modern languages, et cetera. They are acquiring thereby the necessary training and experience to qualify for full professional status or standing. Those in industrial corporations are engaged in professional work on problems confidential to management, whether their work be control, research or development.

The term "professional" should be applied only to those who have the baccalaureate degree or its equivalent by specific accomplishment, and who, having been graduated from institutions approved by the American Chemical Society, have had at least two years of postgraduate training in chemistry or chemical engineering in institutions of like grade or have for an equal period obtained experience in chemical work. For graduates of other educational institutions five years of postgraduate training and/or experience subsequent to the baccalaureate degree should be required. These are the minimum requirements for full professional membership in the American Chemical Society.

The board of directors has heretofore hesitated to make any suggestions on the matter of adequate compensation. On the whole our educational institutions and chemical corporations have realized the value of brains and have compensated employes accordingly. The chemical profession as a whole is on a level with any other profession in material return. There are to-day in our profession, as in many others, individuals whose compensation is high, indeed almost fabulous, and others who are grossly underpaid. There are many who, even in the higher brackets, earn more than their income. There are some, even in the lower brackets, who are not worth their hire, and who should, for their own sakes and for the reputation of the profession, seek other more fitting fields for a livelihood.

In spite of this generalization there has come to the attention of the board of directors evidence that there are to-day many cases where worthy professional men with years of study and training are grossly underpaid and are receiving less compensation than men without any specialized education employed in many of the trades and crafts.

In the opinion of the board of directors, the time has arrived when it must publicly suggest to all employers of chemists and chemical engineers that they review with care their employer-employe relations in this line of endeavor. The American Chemical Society stands ready through a carefully chosen committee on economic status to act in an advisory capacity both to employers and to employe groups of

its members and, if deemed helpful, to publicize its findings. Enlightened management will, it is believed, welcome consultation with such a committee composed of carefully chosen individuals.

As a beginning, the board of directors suggests that all worthy chemical internes and professionals when engaged in professional work be paid on a salary and not on an hourly basis.

The extent of training, experience and capacity, as well as individual personality and merit, are factors that must be considered when employing one to engage in professional work. Bearing these factors in mind, as well as the objects of this society, and the requirements for membership therein, the board ventures to make the following suggestions to employers for their consideration in respect of starting salaries for chemical internes and professionals under present economic conditions, when such persons are employed to do professional work:

A minimum starting salary not less than $1,500 per annum for any chemical interne; and one of not less than $1,800 per annum for any chemical interne of better than average ability or training, including especially those graduated from institutions whose chemical work is of particularly high quality such as those approved by the American Chemical Society; and a minimum starting salary of not less than $2,400 per annum for any individual who has attained "professional" grade as hereinbefore described and, according to the extent of training and capacity, higher starting salary in proportion to training, experience, merit and individual accomplishment.

The foregoing suggestions are for minimum starting salaries only and are not to be regarded as suggestions for maximum salaries or as recommendations for a wage scale. They are made in respect of only those who are engaged for professional work in the field of chemistry and chemical engineering, as the society can not concern itself with problems of employment in other fields.

Inasmuch as technicians normally come under non-professional status, the technician grade does not come within the purview of this organization.

The board of directors recommends to employer and employe alike personal contact and careful consideration before concluding financial arrangements. Also it respectfully reminds both employers and members of this organization that the Employment Clearing House held at the semi-annual meetings of the society affords special facilities for consultation.

The committee on economic status will give its immediate consideration to the whole question of employment in professional work in the field of chemistry.

SPECIAL ARTICLES

P-AMINOBENZOIC ACID PREVENTS THE GROWTH-INHIBITORY ACTION OF SULFANILAMIDE[1]

WOODS[2] discovered that p-aminobenzoic acid counteracts the inhibitory effect of sulfanilamide on the multiplication of bacteria in suspensions. He obtained this effect not only with commercially prepared p-aminobenzoic acid, but also with a substance, extracted from yeast, which appeared to be chemically identical with the acid.

Woods's results have been confirmed by the work of Landy and Wyeno,[3] who found that the bacteriostatic effect *in vitro* of sulfanilamide, sulfapyridine and sulfathiazole on streptococci, pneumococci and staphylococci, respectively, was completely neutralized by p-aminobenzoic acid. The extraction of p-amino-benzoic acid from yeast has been confirmed by Rubbo and Gillespie.[4]

The present report will serve to record the application of Woods's findings to the action of sulfanilamide and p-aminobenzoic acid on a dermatophyte.

METHODS AND MATERIALS

A strain of the fungus, *Trichophyton purpureum* (Bang), was secured from fragments of skin of a patient suffering from dermatomycosis. The organism was cultivated on honey-peptone agar slants for approximately two months, at the end of which time spores were abundant and the mat fairly friable. From this culture a suspension for inoculation was prepared by adding 10 cc of sterile physiological saline solution to the slant, breaking up the mat with a sterile needle and agitating the suspension. The latter was then centrifuged and washed three times, and the final precipitate resuspended in 10 cc of saline solution. The standard inoculum for each Petri dish consisted of one loopful of this suspension.

The spore suspension was inoculated on sterile agar plates, which were incubated at 28° C. in order to obtain optimum growth. The growth-rate of the cul-

[1] From the Laboratory of Surgery of the Yale University School of Medicine, New Haven, Connecticut. The experiments were aided by funds granted to Dr. K. W. Thompson by the John and Mary Markle Foundation and by the Yale University School of Medicine from the Clinical Research Funds.

[2] D. D. Woods, *Brit. Jour. Exp. Path.*, 21: 74–90, April, 1940.

[3] M. Landy and J. Wyeno, *Proc. Soc. Exp. Biol. and Med.*, 46: 59–62, January, 1941.

[4] S. D. Rubbo and J. M. Gillespie, *Nature*, 146: 838–9, December, 1940.

tures was estimated in terms of colony diameter; two diameters of each colony were measured at approximately 3-day intervals for three weeks.

The agar medium in each case was a balanced stock base having the following composition: distilled water, 1,000 cc, dextrose, 20 g, $MgSO_4$, 0.5 g, KH_2PO_4, 1 g, KCl, 0.5 g, $FeSO_4$, 7 H_2O, .01 g, agar, 15 g. To each liter of medium was added 2 grams of a nitrogen source. The salts $NaNO_3$ and $(NH_4)_2SO_4$, the amino acid asparagine and the protein egg albumin served as nitrogen sources. Peptone was not used as a source of nitrogen, since it masks the effect of sulfanilamide. This fact was ascertained by preliminary experiments, thus confirming for the test-fungus the results obtained by Lockwood for bacteria.[5]

Each Petri dish was prepared in such a way that when the nutrient agar was added there was the appropriate amount of sulfanilamide (1:1,000), or p-aminobenzoic acid (1:5,000, 1:10,000, 1:50,000, 1:100,000, 1:500,000) or both. Control plates contained only the nutrient agar.

Experimental Results and Discussion

The addition of sulfanilamide in 1:1,000 concentration to any of the above-mentioned media caused complete inhibition of mat growth, although germination of spores occurred. This inhibition was entirely nullified by the addition of p-aminobenzoic acid in concentrations as low as 1:500,000. However, addition of the acid alone to the culture media had no effect in increasing the rate of growth.

Differences in source of nitrogen brought about slight changes in the basic growth-rate, but did not materially alter the inhibiting effect of the sulfanilamide nor the antagonistic effect of the acid.

These results agree with those obtained by Woods for bacteria; in both cases the p-aminobenzoic acid exerts a striking interference with the inhibitory action of sulfanilamide. Woods has offered the suggestion that p-aminobenzoic acid is a substance, occurring naturally in yeasts, which acts as a co-enzyme in a phase of bacterial metabolism and is therefore an essential growth-substance for bacteria.[6] He further suggests that sulfanilamide, because of its structural similarity to the acid, is able to substitute for the latter in the enzyme reaction and thus interfere with normal metabolism. Only by the addition of an excess of the acid can the inhibitory effect of sulfanilamide be overcome. The fact that relatively small quantities of the acid are able to counteract the effect of the sulfanilamide appears to indicate a preference on the part of the organism for the acid. Although the experiments herein reported do not in themselves confirm such a hypothesis, they do give added evidence for its plausibility.

NAOMI S. DIMOND

SCHOOL OF MEDICINE,
YALE UNIVERSITY

[5] J. S. Lockwood, *Jour. Immunol.*, 35: 155–190, September, 1938.

[6] S. Ansbacher has recently found the acid to be a growth-promoting factor for the chick, and believes it to be one of the factors of the vitamin B complex. SCIENCE, 93: 164–5, 1941.

THE INHIBITION OF BRAIN OXIDATIONS BY A CONVULSANT BARBITURATE

QUASTEL and his collaborators[1] hold the view that narcosis is essentially an inhibition of brain glucose oxidation. They have shown that barbiturates, as well as other narcotics, depress the *in vitro* oxidation of glucose, pyruvate and lactate by brain slices, apparently by inhibition of dehydrogenases.[2] They believe that this inhibition occurs with concentrations which are of the same magnitude as those which produce anesthesia *in vivo*. The oxidations of yeast, and the oxidation by brain of succinate, p-phenylenediamine and a-glycerophosphate remain uninhibited by the same concentration. Thus they differentiate narcotics from tissue poisons which inhibit oxidations in general.

Sodium 1,3-dimethyl-butyl-ethyl barbiturate[3] has recently been synthetized and studied by Swanson and Chen.[4] It differs chemically from sodium pentobarbital only in the 3-methyl substitution on the butyl side chain, but in contrast to the depressant action of pentobarbital, this compound produces convulsions in warm-blooded animals. In view of the inhibitory effect of pentobarbital on glucose oxidation by brain slices it seemed possible to use this closely related compound, with its strikingly aberrant action in the intact animal, to test this theory of narcosis.

The oxygen consumption was measured by the direct method of Warburg, using 1.9 cc of Kreb's phosphate-saline, pH 7.2 at 38° C. Fifty to 100 mgms wet weight of freshly sliced whole rat brain were used. The barbiturate was dissolved in the same medium, and added from the side arm of the vessel after allowing a preliminary period for determination of the normal respiratory rate of the tissue. Control vessels were run in all cases. To eliminate the possibility that this compound is a tissue poison in the concentrations used, its effect on yeast oxidation was tested by the same method. No inhibitory effect was observed in a concentration of 50 mgm per cent.

[1] J. H. Quastel and A. H. M. Wheatley, *Proc. Roy. Soc. London*, B 112: 60, 1932; M. Jowett, *Jour. Physiol.*, 92: 322, 1938; J. H. Quastel, *Physiol. Rev.*, 19: 135, 1939.

[2] D. R. Davies and J. H. Quastel, *Biochem. Jour.*, 26: 1672, 1932.

[3] We wish to thank Dr. E. E. Swanson of the Lilly Research Laboratory for kindly supplying this compound.

[4] E. E. Swanson and K. K. Chen, *Quart. Jour. Pharm. and Pharmacol.*, 12: 653, 1939.

TABLE I

THE EFFECT OF SODIUM 1,3-DIMETHYL-BUTYL-ETHYL BARBITURATE ON RAT BRAIN SLICE RESPIRATION

Final barbiturate concentration	Substrate	Number of experiments	Average per cent. 0–60 Min.	Inhibition of QO_2 60–120 Min.
Mgm per cent.	200 mgm per cent.			
0.1	Glucose	3	+ 3	− 6
1.0	"	5	− 7	− 6
5.0	"	2	−17	−19
10.0	"	6	−16	−25
50.0	"	6	−43	−77
10.0	Succinate	2	− 7	− 3
50.0	"	2	+ 3	− 2

From the results given in Table I it is apparent that sodium 1,3-dimethyl-butyl-ethyl barbiturate is effective in producing inhibition of glucose oxidation of rat brain slices. Assuming equal distribution of the drug, calculations from data of Swanson and Chen,[3] on the rat, establish approximate tissue concentrations of 1 and 2 mgm per cent. for convulsive and lethal doses, respectively. A comparable inhibition of rat brain oxidation is observed with equivalent concentrations of sodium pentobarbital, but when administered to the intact animal in doses equivalent to those of the aberrant barbiturate it produces depression. These results are not explained by Quastel's theory of anesthesia.

F. A. FUHRMAN
A. W. MARTIN
J. M. DILLE

THE DEPARTMENTS OF PHARMACOLOGY AND PHYSIOLOGY,
UNIVERSITY OF WASHINGTON

INDICATIONS OF AN INCREASE IN NUMBER OF C-ATOMS IN ACIDS AND NUMBER OF ACIDS IN SEED FATS WITH ADVANCE IN EVOLUTIONARY POSITION

IN the latest compilation of analyses of seed fats,[1] data from 16 natural orders (Engler and Prantl classification) are given. When the component acids of the families of these orders are considered it is found that 7 orders have an increase in the number of acids, 8 have an equal number of acids and one has a decrease in the number of acids with an advance in evolutionary position of their constituent families.

When the number of carbon atoms of these acids is considered it is found that 8 orders have an increase in the number of C-atoms, 6 have equal number of C-atoms and 2 have a decrease in the number of C-atoms with an advance in evolutionary position. If, however, the terminal families of those analyzed of the Malvales, Myrtiflorae, Contortae and Tubiflorae (*i.e.*, respectively, Sterculiaceae, Myrtaceae, Asclepiadaceae and Acanthaceae) be removed from consideration, then 3 of these 4 orders show an increase in the number of acids and all 4 show an increase in the number of C-atoms in these acids with an increase in evolution. An increase in the number of C-atoms indicates in these instances an increase in molecular weight of the acids which contain them.

The data may be summarized as follows: *Fagales*—Betulaceae Number of C-atoms 14–16–18, number of acids 5; Fagaceae 16–18–24, acids 6: *Urticales*—Ulmaceae, 10–12, acids 2; Moraceae 18, acids 3: *Santalales*—Santalaceae 16–18, acids 2; Olacaceae 16–18–20–26, acids 8: *Ranales*—Berberidaceae 16–18, acids 4; Menispermaceae 16–18–20, acids 6; Magnoliaceae 16–18, acids 4; Anonaceae 16–18–24, acids 6; Myristicaceae 10–12–14–16–18, acids 8; Lauraceae 10–12–14–16–18, acids 6: *Rhoeadales*—Papaveraceae 14–16–18–20, acids 9; Cruciferae 16–18–20–22–24, acids 9: *Rosales*—Rosaceae 14–16–18–20, acids 10; Leguminosae 14–16–18–20–22–24, acids 9+: *Geraniales*—Tropaeolaceae 16–18–22, acids 5; Linaceae 14–16–18–20, acids 7; Rutaceae 16–18–24, acids 6; Simarubaceae 10–12–14–16–18, acids 10; Burseraceae 16–18–20, acids 5; Meliaceae 14–16–18–20, acids 7; Vochysiaceae 12–14–16–18, acids 5+; Euphorbiaceae 14–16–18–20, acids 10: *Sapindales*—Buxaceae 18–20, acids 3; Anacardiaceae 14–16–18–20, acids 6; Celastraceae 16–18, acids 6; Salvadoraceae 8–10–12–14–16–18, acids 7; Staphyleaceae 16–18, acids 4; Hippocastanaceae 16–18, acids 5; Sapindaceae 10–12–14–16–18–20–22–24, acids 11: *Rhamnales*—Rhamnaceae 16–18, acids 5; Vitaceae 16–18–20–22, acids 8: *Malvales*—Tiliaceae 16–18, acids 4; Malvaceae 14–16–18–20, acids 7; Bombacaceae 14–16–18–20–24, acids 7; Sterculiaceae 16–18, acids 4: *Parietales*—Caryocaraceae 14–16–18, acids 5; Theaceae 14–16–18–20, acids 6; Guttiferae 14–16–18–20–22, acids 7; Dipterocarpaceae 14–16–18–20, acids 6; Flacourtiaceae 16–18, acids 7; Passifloraceae 16–18–20–26, acids 8; Caricaceae 16–18–20, acids 5: *Myrtiflorae*—Elaeagnaceae 16–18, acids 5; Lecythidaceae 14–16–18, acids 5; Combretaceae 14–16–18–20, acids 6; Myrtaceae 16–18, acids 5: *Umbelliflorae*—Araliaceae 16–18, acids 4; Umbelliferae 16–18, acids 4: *Contortae*—Oleaceae 16–18, acids 4; Apocynaceae 16–18–20–24, acids 7; Asclepiadaceae 16–18, acids 4: *Tubiflorae*—Convolvulaceae 16–18, acids 5; Verbenaceae 16–18, acids 4; Labiatae 18, acids 3; Solanaceae 14–16–18–20, acids 6; Scrophulariaceae 16–18, acids 5; Pedaliaceae 16–18–20, acids 5; Acanthaceae 14–16–18, acids 6: *Rubiales*—Rubiaceae 10–14–16–18–20, acids 7; Caprifoliaceae 16–18–20, acids 6; Valerianaceae 16–18, acids 5; Dipsacaceae 16–18, acids 4.

JAMES B. MCNAIR

LOS ANGELES, CALIF.

[1] T. P. Hilditch, "The Chemical Constitution of Natural Fats," John Wiley and Sons, 1940.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN APPARATUS FOR THE DETERMINATION OF THE SOLUBILITIES OF GASES AT HIGH TEMPERATURES AND HIGH PRESSURES

THE apparatus consists of a modified Ipatieff rotating bomb and a sampling arrangement separating the dissolved gas from the solvent in samples withdrawn from the bomb.

The rotating bomb (Fig. 1) is provided with two

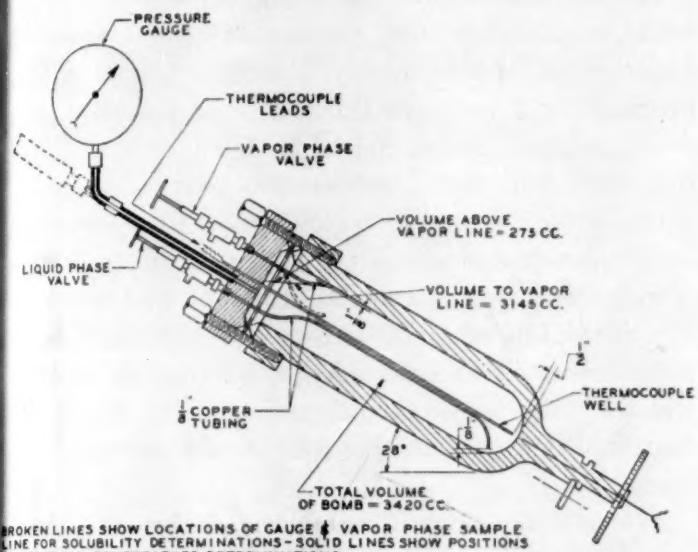
PRESSURE GAUGE
THERMOCOUPLE LEADS
VAPOR PHASE VALVE
VOLUME ABOVE VAPOR LINE = 275 CC.
LIQUID PHASE VALVE
VOLUME TO VAPOR LINE = 3145 CC.
1/2"
THERMOCOUPLE WELL
1/8" COPPER TUBING
28°
TOTAL VOLUME OF BOMB = 3420 CC.
BROKEN LINES SHOW LOCATIONS OF GAUGE & VAPOR PHASE SAMPLE LINE FOR SOLUBILITY DETERMINATIONS - SOLID LINES SHOW POSITIONS FOR CRITICAL TEMPERATURE DETERMINATIONS.

FIG. 1

needle valves attached to sampling lines, the shorter terminating just below the head of the bomb and the longer reaching the lower end or bottom of the bomb, making it possible to remove vapor phase and liquid phase samples when the bomb is operated at an angle of 20–30 degrees with the horizontal.

The sampling arrangement (Fig. 2) consists of a

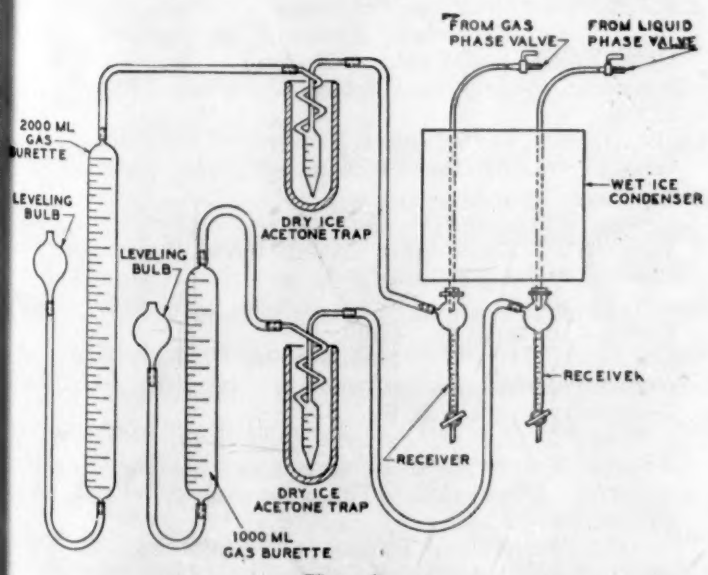

FIG. 2

wet ice condenser with receiver, trap and a gas burette of 1,000 cc capacity for liquid phase samples and a similar device for vapor phase samples but with a gas burette of 2,000 cc capacity. The traps are immersed in a cooling bath at a temperature sufficiently low to condense the solvent escaping condensation in the wet ice receiver but allowing the gas to collect as such in the gas burettes when the samples are released to atmospheric pressure through the needle valves on the bomb head. The gas is collected over saturated sodium chloride solution.

A similar but smaller apparatus is used for purging the draw-off lines before the main samples are taken.

In making solubility determinations the bomb is charged with solvent to about one half its total capacity (3,420 cc). The gas is then charged at room temperature, the initial pressure depending on the temperature and pressure range of the solubilities to be determined. The bomb is set in rotation and heated to the desired temperature level. The rotation is stopped after one half hour, sample lines purged, the vapor phase sample (700–1,000 cc gas) and the liquid phase sample (7–9 cc condensate) taken. When the composition of the vapor phase and liquid phase samples differ, a two-phase condition exists in the bomb and the solubility can be calculated from the composition of the liquid phase sample. When the composition of the two samples is the same a one-phase condition prevails and no solubility of gas in liquid as such exists.

If the bomb is charged at different initial pressures, *e.g.*, 10, 25, 50, 75 atms., and solubilities determined at various temperatures for each initial pressure, curves may be drawn plotting temperatures and corresponding pressures *vs.* solubilities. Isotherm or isobar curves may then be derived.

In the determination of critical temperatures, the bomb is charged with the material investigated, the charge may vary from 20 to 50 per cent. of the capacity of the bomb. The bomb is set in rotation and the temperature raised about 1° C. per minute, taking the pressure and temperature readings at not greater than five minute intervals. The pressure *vs.* temperature is plotted on uniform scale. The pressure-temperature curve will show a "break" or point of discontinuity which will be within $\pm 2°$ C. of the critical temperature of the material, as determined by the usual methods.

In case of pure substances the existence of a two-phase condition below the break and a one-phase state above the break may be confirmed by running the pressure-temperature curve in the presence of hydrogen (initial pressure < 10 atms.) and comparing the compositions of samples taken from the vapor phase and liquid phase sample lines, the presence of hydro-

gen in the amount given above not affecting the break on the pressure-temperature curve to any noticeable amount.

The critical temperatures of two-component systems may be determined by the same procedure.

This apparatus can be used for other studies such as the investigation of equilibria in heterogeneous systems.

V. N. IPATIEFF
G. S. MONROE

RESEARCH LABORATORIES,
UNIVERSAL OIL PRODUCTS COMPANY,
RIVERSIDE, ILL.

A SAFETY SWITCH FOR WATER-COOLED X-RAY TUBES

SINCE water-cooled x-ray tubes may be damaged if the flow of water is interrupted during operation, it is a common practice in physics laboratories to insert in the control circuits of x-ray machines so-called bucket switches which are held closed by the weight of the water that leaves the cooling system of the tube but which open automatically if for any reason this flow ceases. Such switches are satisfactory where the waste water can be dumped into a sink and where bulk is not a disadvantage. However, because they take up considerable space and can not be connected into a closed water system, it may be inconvenient or impossible to employ bucket switches in connection with medical x-ray apparatus.

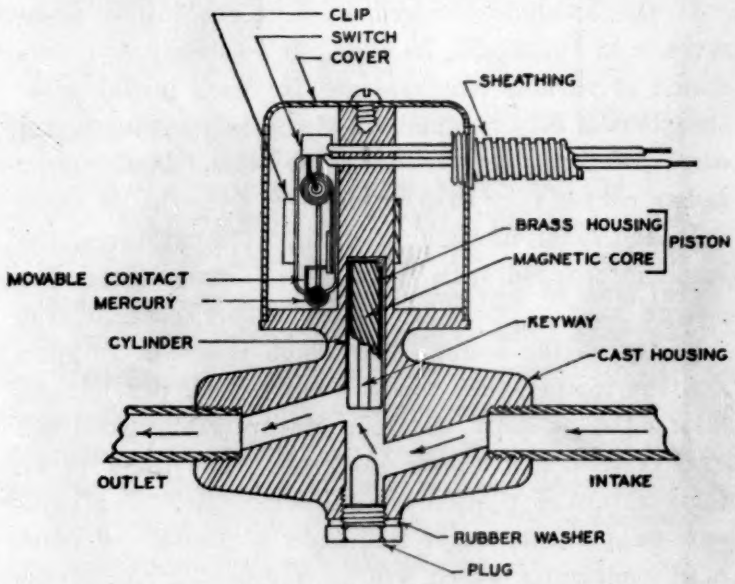

FIG. 1. Flow switch.

There is described here a simple, small, dependable flow switch which can be connected into a closed water-cooling system. The switch is normally open, closing when water flows through it and opening again when the flow stops, either because of pressure failure or a clogged waste line. The switch itself (a commercial product, Mercoid Magnetic Switch, No. 9-81R) consists of a glass capsule containing a pool of mercury and two electrodes. One electrode is permanently bathed in the mercury; the second is held away by means of a coil spring but makes contact with the mercury whenever a permanent magnet is brought up to the side of the capsule.

The mercury switch is mounted against the outside of a vertical brass cylinder within which lies a piston made up of a brass housing surrounding a magnetic core. The fit between piston and cylinder is purposely loose and to further facilitate leakage between the two a longitudinal keyway is cut in the piston.

The magnetic core of the piston consists of a cylindrical, cobalt-alloy steel, permanent magnet having a diameter of approximately 9 mm, a length of approximately 3 cm (one third of a commercial cylindrical magnet, Central Scientific Company of Chicago, No. 78295-B).

Operation: When no water is flowing through the switch, the piston under the action of gravity moves down until it strikes a mechanical stop, in which position direct communication between intake and outlet ports is cut off and the magnet is below the level at which it will operate the magnetic switch. The latter, therefore, is open and the x-ray machine can not be operated.

When water flows through the device, the piston moves upward until a free communication is established between intake port and outlet port in which position the armature of the magnetic switch is attracted, the second electrode makes contact with the mercury, the control circuit of the x-ray machine is completed and the x-ray tube can be operated.

PAUL C. HODGES

UNIVERSITY OF CHICAGO

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